# ZOOGOER

March-April 1988

**Friends of the National Zoo**

is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

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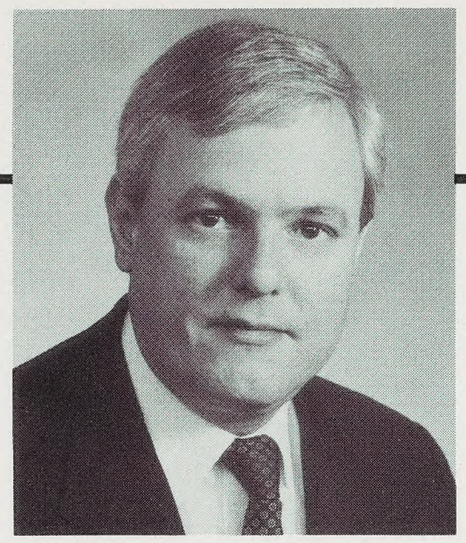
**Cover**: *Persian onagers graze on the rolling hillsides of the Zoo's Conservation and Research Center. Located in Front Royal, Virginia, the facility is the site of numerous studies and programs that receive FONZ support. Photo by Jessie Cohen, NZP Graphics.* **Centerspread**: *1987 FONZ Photo Contest winner John Caron snapped this portrait of an NZP ostrich.*



# A Perfect Partnership

Having been honored to serve as the President of the Friends of the National Zoo for the past six months, it is perhaps time for me to take a moment to reflect upon the extraordinary nature of our endeavor. It is all the more appropriate because FONZ will celebrate its 30th birthday this year!

FONZ is both a family business and a Public/Private Partnership. Thanks to the founders from the local community and the National Zoological Park, FONZ was given a dual nature containing each of these highly successful forms of enterprise, thus creating as rare and beautiful an animal as many of the species preserved by the National Zoo.

On the one hand, FONZ is a family business, a rather large family business run by a rather large family, as you will note in the Annual Report. In this capacity, FONZ is a contractor leasing the Food, Gift, and Parking services at the National Zoo from the Smithsonian Institution. We are therefore rightly held to high standards in the performance of our many duties at the Zoo. How often have we each complained that the operators of a given establishment have no regard for us as their customers? FONZ concessions are operated by employees hired by FONZ members. Who cares more about visitor services than we do? More importantly, who could be more concerned about the quality of the National Zoo experience than the individuals and families who are the Friends of the National Zoo? This is the reason that you will never be subjected to the high-pressure sales techniques of a strictly profit-motivated money machine while visiting our peacefully natural park. On the other hand, isn't it nice to know that the considerable "net proceeds" generated from the dollars you and I do spend at the concessions are used by the Zoo according to the priorities established by the Zoo Director, and contribute to the very quest for a quality Zoo that caused us to join FONZ in the first place? It must be said that the family business half of FONZ gives it strength of body and provides tangible reinforcement of its purpose.

There is another, perhaps more important, half of this rare corporate organism that we call FONZ. Its spirit, its very soul is comprised of the members. Our participation in the volunteer and educational activities our membership dollars support, permits us to give part of ourselves as private citizens to an institution committed to work in areas we believe in, while receiving valuable knowledge packaged in pleasurable experiences in return.

Recently, Public/Private Partnerships have been universally hailed throughout our nation as enormously successful vehicles for the achievement of public good. This splicing of the genes of public and quasi-public agencies with capitalistic private enterprise is applauded as a new creation, yet FONZ has been just this kind of *rara avis* from its very beginnings!

The most valuable contribution we as humans can make is the gift of that one quality that makes *Homo sapiens* the most successful species on earth; the gift of human ingenuity, human creativity and human caring. The Annual Report will show hundreds of private people giving this gift many thousands of times to the quasi-public National Zoological Park. A quintessential Public/Private Partnership if I ever saw one!

Dr. Roscoe M. Moore, Jr. served FONZ with great distinction as its leader and pathfinder for the last several years. His wisdom is an inspiration to all of us, and his caring energy has kept FONZ healthy and prosperous. We are all grateful for his herculean past services, and the Board of Directors is very happy that Roscoe remains one of us.

George A Didden III

George A. Didden, III
President

# ZOOGOER

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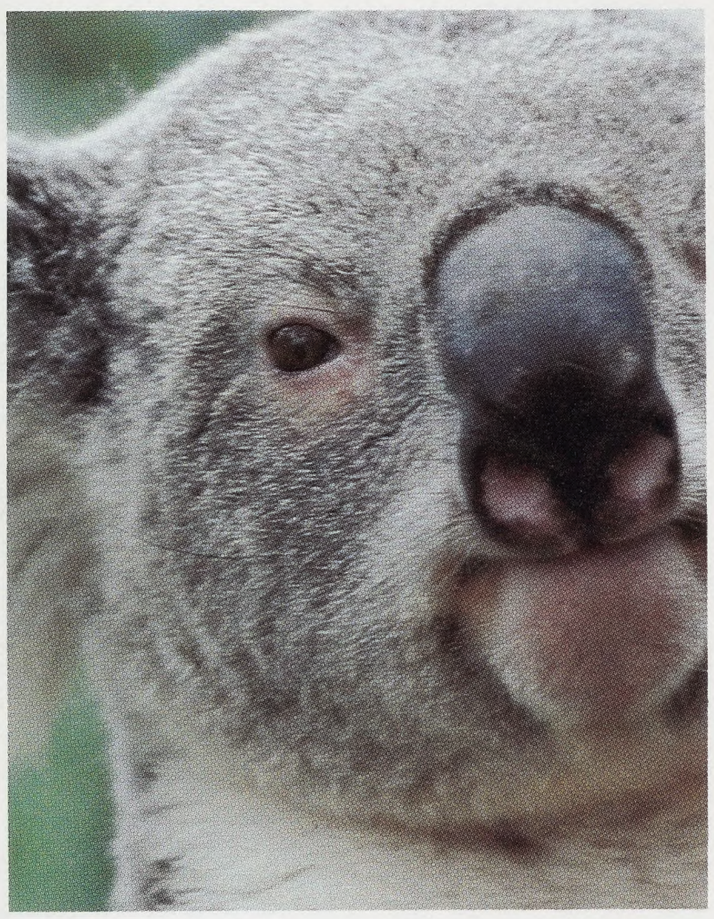

*Koala (above), and Echidna (below). (Photos by Michael Hutchins)*

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# Singing in the Rainforest

*Warren Brockelman*

After more than 10 years of listening to gibbons sing in the rainforests of Thailand, of creeping through the thick forest under cover of bushes and small trees to peek into their private lives, I am convinced that the "essence of gibbon" is inseparable from the forests these animals inhabit. But to watch a family of gibbons swing from branch to leafy branch in an enormous enclosure set among towering trees in Gibbon Ridge is to begin to sense what gibbons are about. There is more to gibbons than meets the untrained eye.

Zoologists recognize at least nine different species of gibbons, all of which reside in the forests of Southeast Asia and in parts of central Asia to the north. The siamang, even though it is twice as heavy as the gibbons, is placed in the same genus—*Hylobates*. Gibbons and siamangs together comprise the "lesser apes" and are given the family name, Hylobatidae.

The lesser apes have not undergone very much adaptive radiation or divergence in their behavioral ecology. All species seem marvelously well-adapted to living in the middle and upper stories of the tropical forest tree canopy, and in fact gibbons are almost completely dependent for their survival on the upper layers of the forest. All consume a diet of shoots, leaves, a large variety of fruits, and small invertebrates such as termites. All of the gibbons are lanky, with unusually long arms and exceptional flexibility and grace of movement.

The first time I saw a gibbon dash with reckless abandon through a complex tangle of tree branches and vines and then dive 30 feet through the air to the next tree, I couldn't believe my eyes. Gibbons effortlessly perform giant rolls and great leaps that a human gymnast could achieve only with the greatest difficulty, if at all. They have no peers in the brachiating, climbing, and leaping forms of locomotion. And they execute these feats quite casually as they move around their territory, foraging from limb to limb and from tree crown to tree crown for a bite of leaf or a juicy berry. Evidence of healed fractures in wild gibbons shows that they do occasionally miss a handhold and may break an arm or leg if they cannot catch another limb—or catch a dead limb—as they fall. Clearly the gibbons' form of locomotion can be dangerous, and requires practice and superb conditioning.

### Gibbon Song

Just at dawn, from anywhere in the Zoo and even beyond into Mount Pleasant, you may be regaled with the songs of gibbons. All female gibbons sing "great-calls," and in most species their mates accompany them in a stereotyped and ritualized duet. The female gibbon's great-call has been described as a "brilliant theme lasting 20 seconds or more, repeated every two to five minutes. It swells in volume after soft opening notes, achieves a climax in pitch, intensity, or rapidity (at which the gymnastics occur), then subsides." Duets begin with "hoos" or hoots, and consist primarily of repeated sequences of great-calls by the female, followed or accompanied by hoots, trills, or barks from the male. Juveniles in a family group may also join in. Duetting, especially the swinging and leaping in the trees that highlight the female's great-call, consumes an enormous amount of gibbons' time and energy in the wild, indicating its importance in the animals' daily lives.

All gibbon duets are complex, and are especially so in the Zoo's gibbon species—the siamang (*Hylobates syndactylus*) and the white-cheeked or concolor gibbon (*Hylobates concolor*). Behavioral biologists have puzzled for years over the duets, which are so intricate that merely describing and comparing their patterns and acoustical properties in a meaningful way has been a challenge. Trying to understand why gibbons duet has taxed the ingenuity of biologists even further.

For instance, the duet of each species is highly distinctive and human listeners can distinguish between the species by the duet alone. Thus an early hypothesis to explain this marvelous and beautiful diversity was that the gibbons also used the duets to discriminate between the species. But we now believe that different species of gibbons evolved in allopatry, or isolation, from one another. Except for the siamang, each species occupies an exclusive geographic range. Therefore, it is unlikely that the complex songs evolved to aid the gibbons in correctly identifying members of their own species.

Gibbons are monogamous and live in small family groups of parents and their offspring. Although other primate species, such as tarsiers and golden lion tamarins, also tend to monogamy, none seems as strict about it as the gibbons. Gibbons mate for life, or until a member of the pair dies or is displaced by a stronger individual. Extra spouses or "extramarital affairs" have never been observed.

Thus another possible function for the duets is that they somehow help to "cement the pair bond" between a male and female and promote cohesion within the group. All mated pairs duet and only mated pairs seem to duet. Moreover, the male and female of all species (with the single exception of the hoolock gibbon of Burma and Assam) sing distinctive parts in the duet typical of the species. Singing may be considered part of the gibbons' sexual behavior although it is not immediately associated with reproduction. The role of duetting in group life is easily perceived in Zoo gibbons. But to appreciate its function in distance communi-

*Although reserves protect gibbons in the wild, further measures, such as zoo breeding programs, may prove important to the survival of the species. (Photo by Jessie Cohen, NZP Graphics)*

cation between groups of gibbons, a trek into an Asian tropical forest is almost essential. Indeed it is hearing the duets of many groups echoing through the forest on a calm sunny morning that makes the hardships of studying wild gibbons worthwhile.

Gibbons live in a territorial society, with each family group occupying a forest area of between 15 and 40 hectares. In high-quality habitats in Thailand four or five gibbon groups, each with an average of four members, may live in a one square kilometer area. Songs carry one to two kilometers through the forest, so as many as 50 or more gibbons may be heard singing at once!

The extreme amplitude of gibbon songs alone suggests that they have an important role in communications between groups. The gibbons' behavior seems to indicate this as well. Sometimes a group will call in response to certain types of calls from a neighboring group. Other times, a group begins moving toward the source of the songs. Frequently, however, on hearing songs from neighbors, members of a group simply stop picking fruit or chewing leaves, glance in the direction of the calls and listen for a moment. The adult male might also climb to the top of a tree to look around, or perhaps to hear better. What are they thinking? We can make a few informed guesses based on what we, as human listeners and observers, understand about the distant singers from the way they sing.

We slowly learn to recognize a duet as belonging to a neighboring group because individual differences exist in the pattern, structure, and frequency of songs. We can also tell whether the singers are in their own territory or not. We might even be able to glean some information about the gibbon's mood and physical well-being—healthy mated adults sing well and vigorously together. An experienced listener can thus learn much about social relations among gibbons just by listening to duets and to various types of solo vocalizations.

One story of shifting social relationships in a group of white-handed gibbons (*Hylobates lar*) living in the Khao Yai National Park in central Thailand illustrates this. An adult male in one of our study groups was attacked and his upper arm seriously injured by a neighboring male. This impaired his ability to brachiate and he had a hard time keeping up with his family as they foraged. Sadly, his mate seemed to lose interest in duetting with him—and it is usually the female who initiates a duet. Within six months he had disappeared from the territory. His oldest son, fully-grown but still a sub-adult, took over territorial defense and actually duetted with his mother, although not so vigorously as a paired adult male.

Several months later, the neighboring group dramatically changed in structure. Researcher Uthai Treesucon, who had been following this group for two years, heard a duet one day and realized that the female had a new mate. Uthai immediately recognized from his voice that the new male was the subadult described above. This young male had apparently decided to leave his mother and take over his neighbor's wife and territory! Unfortunately, we did not see the actual takeover. This young male's mother, left with no male to help defend her territory, deserted the area. Her two juvenile sons, however, moved in with their older brother's new family group. They are still living in this territory, along with their stepmother's offspring and two more young fathered by their brother.

The loud songs of gibbons seem to advertise that a territory is occupied—and to warn other gibbons to stay out. Most singing, however, evokes little response from neighbors and may just reaffirm the social status quo. Nonetheless, occasionally the vigorous response of an adult male to unexpected calls or songs of intruders shows that these vocalizations also function in territorial defense. For example, Jeremy and Patricia Raemaekers in Thailand and John Mitani in Indonesia played tape-recorded gibbon calls in different locations to see how the gibbons responded. When played within a group's territory, recorded calls nearly always elicited an aggressive response from the residents, especially from the adult male who immediately swung over to investigate the "intruder."

*Blond at birth, white-cheeked gibbons turn black as juveniles; at maturity only females revert to the light coloration. (Photo by Jessie Cohen, NZP Graphics)*

### Monogamy?

The male gibbon's major contribution to his family group is defense of their territory and its year-round food supply. Recently, however, biologists have begun to wonder why gibbons are so strictly monogamous. Some biologists suggest that a single adult male cannot defend a territory large enough to provide food for more than one reproducing female, but there is no compelling reason why this should be the case under all ecological conditions. For instance, in a habitat with superabundant food, a single male's territory should be able to support more than one female. Undoubtedly, female gibbons have some say in how many females will share a male's attention and territory.

Indeed, if two adult females are placed in the same enclosure, one immediately tries to kill the other. Adult gibbons have long sharp canines, and use them with lightning-fast effectiveness in fights. Fights between wild gibbons are nonetheless quite rare and I have never even heard a report of physical fights between wild female gibbons. This suggests that gibbons may be extremely proficient at assessing each others' physical prowess on the basis of their vocal feats, making fights largely unnecessary.

Long-term studies of a decade or more, however, are revealing exceptions to the "rule" that all gibbons live in monogamous pairs, caring exclusively for their own young, which stay with the parents until they are ready to start their own families. In Malaysia, an adult female siamang may share a territory with another group, perhaps her

relatives, or may live alone. The white-handed gibbon group described earlier contained the offspring of three different parental combinations, yet the members live together with no more than the usual family strife.

More surprising are recent observations of white-cheeked gibbons in south China's Yunnan Province. A preliminary survey of several groups revealed not only the presence of an "extra" adult-sized female but also a larger group size—from 6 to 10 individuals—than has been seen in any other gibbon species. Could these gibbons be polygamous? It is too early to say, as the "extra" females have not been seen to produce or carry young. Nevertheless, something is a little odd about the social behavior of white-cheeked gibbons. They have extraordinarily complex and unusual vocal patterns, producing strange, other-worldly, and often ear-splitting sounds. Moreover, the songs are usually not just duets, but are family group "sing-alongs."

The new naturalistic exhibit for the National Zoo's gibbons and siamangs will provide a wonderful opportunity to study the unusual features of their social systems—and their amazing songs. This kind of zoo research grows ever-more important as studies of wild gibbons in their tropical forest habitats become a race against the chain-saws of developers and the guns of poachers. Most of the countries where gibbons occur in the wild have established, or are now establishing, extensive systems of national parks and other sanctuaries to conserve wildlife. Thailand, for example, has completely protected more than 10 percent of its area for conservation, and most of this is gibbon habitat. Viet Nam, one home of the white-cheeked gibbon, is now establishing conservation areas; Indonesia, with five species of gibbons within its borders, is doing the same. But it will be a long time before these areas—or the gibbons' future in the wild—are secure.

Gibbon Ridge will afford Zoo visitors a wonderful opportunity to see gibbons perform their spectacular gymnastics, to hear gibbons sing their marvelous songs...and to imagine themselves in the rainforest of a faraway land. ❑

*Warren Brockelman is on the faculty of the Department of Biology at Mahidol University in Bangkok, Thailand. A visit to the Zoo is always on his itinerary when he travels to the States.*

*Providing vertical space for these canopy-dwelling apes was an important consideration in the design of the Zoo's new Gibbon Ridge exhibit. (Photo by Jessie Cohen, NZP Graphics)*

**Gibbon Ridge**

The Gibbon Ridge exhibit, scheduled to open in May, will display the Zoo's two species of lesser apes in an enclosure reminiscent of their native tropical forests. Designed for white-cheeked gibbons (*Hylobates concolor*) and siamangs (*Hylobates syndactylus*), the exhibit is a spacious wire mesh enclosure which includes two full-grown maple trees.

Like all lesser apes, these long-armed primates are arboreal and rely on brachiation—swinging from branch to branch using their arms—to move through the forest tree canopy. In zoos, however, this behavior is often limited by shortage of space. This is not so at Gibbon Ridge, where the ample space is filled with an intricate network of trapeze-like ladders and live trees.

Two families of gibbons and one of siamangs will be on display in Gibbon Ridge on a rotating basis. Both gibbon families are composed of an adult pair with two sons, while the siamang family is made up of one adult pair with an infant son.

Male and female siamangs are similar in size, but white-cheeked gibbons exhibit sexual dimorphism. The sexes have different coloration, and the Zoo females weigh more then the males. Females are generally golden-blond while the males are black. This phenomenon is not often found in monogamous animals; the case of the siamangs, in which both sexes are black, is more typical of monogamous primates. Males and females in both species also sing different songs, which pairs combine into elaborate, ritualized duets.

Both white-cheeked gibbons and siamangs are threatened in their Southeast Asian tropical forest habitats. White-cheeked gibbons occur in Vietnam, Laos, on the Chinese island of Hainan, and in Yunnan Province in southern China. These gibbons are featured in Chinese art and poetry, an indication of a once-larger range that may have encompassed much of China. The siamang is confined to mainland Malaysia and Sumatra. Both species breed well in zoos, where these marvelous primates are carefully managed to ensure their continued health and survival in captivity.

*—Howard Youth*

# Turning Natural History into Science: The NZP Nexus

*K. Ullas Karanth*

It is a cold and misty morning in Nagarahole National Park in southern India. We are riding on an elephant, traversing an arrow-straight trail through the dense forest and scouting for any sign of movement. The park ranger, Chinnappa, and the elephant's chauffeur, called a *mahout*, are also searching the cover for animals. Suddenly, the flash of a white undertail flag alerts us to a group of chital deer feeding on ripe and juicy fallen fruits. I reach for my rangefinder to measure the distance between us and the deer. As the chital sense us and scatter through the dense undergrowth, we quickly record the distance, sighting angle, and the age and sex composition of the herd. Then we move on, similarly counting other animals we encounter, covering the four-kilometer transect in about two hours. Our observations are recorded first on a data sheet, then are entered into a micro-computer. Later, using a program developed by American biologists, we will estimate the population densities of these animals. Such information on chital and other prey species will, in turn, help us to understand the dynamics of predation in this splendid wildlife reserve.

This work is a part of a pioneering Indo-American collaborative research project aimed at understanding the ecology of the large predators—tigers, leopards, and wild dogs or dholes—that inhabit the Indian forests. Such an understanding is absolutely essential if we are serious about conserving these animals. We hope to synthesize the natural history skills of Indians with the modern biological theories and techniques of Americans. The jungle craft of the Kuruba tribesman blends with the high-technology of the West in an effort to save a part of our global human heritage.

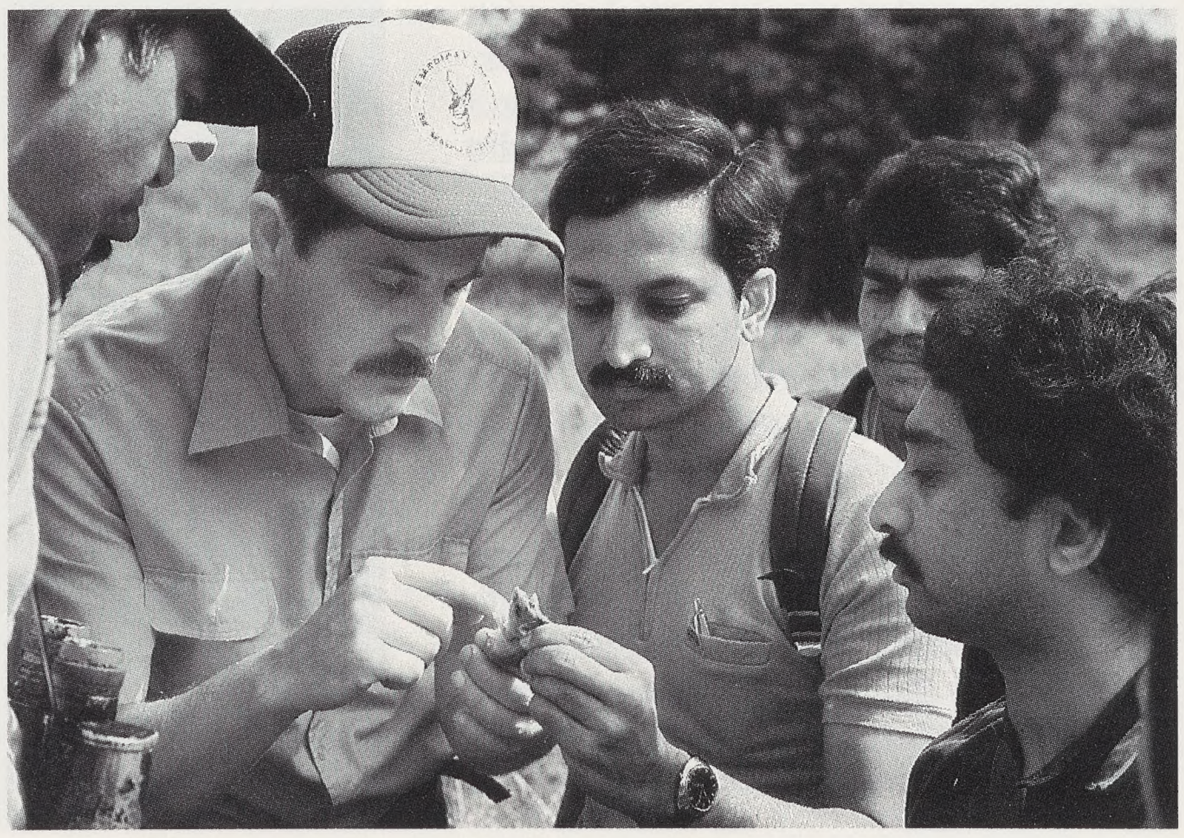
The study is also part of my doctoral research in the Department of Wildlife at the University of Florida. On a more emotional level, it has been, for me, a dream come true. I have come a long way indeed. In no small measure, I owe this experience to the zoo in a far-away land that set me off on this road. I am but one link in an expanding conservation web—the NZP nexus that is putting science into wildlife management in developing countries.

There are many zoos that capitalize on the attraction that beautiful exotic animals from these countries hold for the American public. There are others that send biologists to these countries to study the fantastic animals, and to cover themselves in glory doing so. But there are very few that care enough to help biologists and managers from these countries to do what matters most—to stand on their own feet and manage their wildlife resources wisely in the difficult years to come. The Wildlife Management Training Program of the National Zoo is probably the most effective and far-reaching of all such efforts. What follows is an account of my personal experience of this program as a participant, an experience that is shared by a growing army of third world conservationists.

Ever since my school days in the 1960s, I have been fascinated by wildlife. However, Indian universities have traditionally confined "biology" to laboratories and viewed it only through microscopes. Educational and career opportunities were almost non-existent. So I became an engineer, later a farmer, working hard to build myself a career that was reasonably successful materially, although not spiritually. I continued to be an amateur naturalist, and involved myself with conservation organizations trying to protect India's magnificent wildlife.

In 1983, I was in my mid-30s, well-settled in life and keen on doing wildlife work full-time. Yet I knew wildlife conservation could no longer afford to be merely old-style natural history, resigned to a fatalistic, laissez-faire philosophy. It had to transform itself into dynamic managment based on a solid foundation of modern wildlife biology. The Smithsonian Tiger Ecology Project in neighboring Nepal demonstrated the fruitfulness of such an approach. But the Indian educational system continued to be incapable of fulfilling this need, even as Indian wildlifers fought hard to protect their nature reserves on a more or less *ad hoc* basis. I knew of no place in my country where I could get the kind of training I knew I needed.

In December 1983, the Bombay Natural History Society, India's venerable conservation organization, held an international wildlife conference. Being especially interested in predator ecology, I soon spotted and pounced on the



*Careful study of native wild creatures allowed students to put classroom theory into practice. (Photo by Jessie Cohen, NZP Graphics)*

carnivore biologists in the large gathering. They advised me to meet a Sri Lankan primatologist, Rasanayagam Rudran, who was part of the large NZP contingent at the conference. After listening carefully to tales of my thwarted ambitions of becoming a wildlife biologist, he encouraged me to seek admission to the Wildlife Management Training Program that he runs at NZP's Conservation and Research Center (CRC) in Front Royal, Virginia. When I pleaded that I simply did not have what was by Indian standards the fortune needed to cover my travel and living expenses, Rudy (as he insisted on being called) said that the course was meant for students from developing countries who are not exactly millionaires. He would try to find funds for me if I made it through the selection process. He kept his promise and I got a cable in March 1984, informing me that I had been selected and that the Smithsonian Institution and the Friends of the National Zoo would fund me! I was on my way to the land of Aldo Leopold on a holy pilgrimage!

In the summer of 1984, I was at the sprawling Research Center that nestles in the beautifully wooded Virginia countryside adjacent to the Shenandoah National Park. We were 13 trainees; three each from India and Sri Lanka, two from China and Malaysia, and a trainee each from Nigeria, Zambia, and Peru. The habitats where we worked in our native lands ranged from the rainforests of Malaysia to the African savannas. The species that we worked with included the Indian tiger and the Andean vicuna. Our interests, professions, and cultures differed vastly. But two things united us: Our involvement in wildlife conservation and a keenness to learn.

Rudy was our *guru* for the training program. As a pioneer in the study of tropical forest primates, he has the distinction of having done field work in Asia, Africa, and Latin America. He was assisted that year by Jack Frazier, a herpetologist with an Oxford doctorate, a deep understanding of foreign cultures, and a marvelous sense of humor. Finally, drawing upon all his resources to support the course, was Chris Wemmer, who heads CRC. At our very first meeting, Chris broke the ice with a quip, asking a Sri Lankan trainee named Sammerakoon if there was also a winter-raccoon among the trainees!

Beneath his gentle exterior, Rudy was a tough task master. Hailing originally from the third world, he knew exactly what kind of training we required. The course was tailored to meet our needs and focused on modern quantitative techniques of wildlife research. The program took the "hands-on" approach to field biology that was so sadly lacking in our own countries. Up early in the morning, we slogged hard in the field, with a couple of intensive lecture sessions thrown in. Rudy's strategy was simple. We were taught the theory in the classroom and then rushed out to do exactly what we had been taught. No one could complain about the arduous field work, because Rudy and Jack were out there working side by side with us!

*While conducting observations of the Center's Pere David's deer, students developed techniques applicable to a wide range of social species.*

We were taught how to analyze the structure and diversity of vegetation in the dense woods of CRC. Procedures for identifying plants and measuring species richness, diversity, and habitat structure became easier to comprehend as we actually worked them out. This skill would prove invaluable in assessing wildlife habitats back home.

We studied the fascinating rutting behavior of Pere David's deer. The behavioral observation techniques we learned to use on them could be applied to a wide variety of social animals from monkeys to ungulates. The advantage of systematic sampling of animal behavior over casual recording of natural history observations was forcefully driven home as we meticulously observed, recorded, and analyzed the complex behavior patterns of these Chinese deer, now living only in human-managed herds.

We were taught to live-capture animals using many new techniques, ranging from sophisticated "rocket nets" to trap deer to simple box traps and snares to capture foxes, raccoons, and opossums. These would prove equally useful in catching the antelopes, jackals, and civets of our native lands. We learned the use of simple marking techniques, such as fitting collars and ear-tagging. As we caught, wrestled down, and marked free-ranging white-tailed deer, mist-netted delicate warblers, or ear-tagged small mammals in the forests of CRC, we realized how much more information on the ecology of animals could be obtained from observing marked individuals.

*Working in teams, course participants mastered the basics of field work in a few short weeks. Wildlife censusing, habitat assessment, radiotracking, and other monitoring methods will enhance management of wild areas in the students' native countries. (Photo by Jessie Cohen, NZP Graphics)*

Chemical immobilization of captured and free-ranging mammals was demonstrated to us. We practiced the use of capture guns that shoot drug-tipped darts. These skills would be useful not only for research but also for restraining potentially dangerous animals that stray into human habitations, an all-too-common problem with the predators many of us had to face. We were exposed to modern radiotelemetry techniques which have added exciting new dimensions to studying the many secretive species whose behavioral ecology was once shrouded in mystery. Starting off on treasure hunt-like games in which we had to track down cleverly concealed transmitters, we rapidly graduated to radio-tracking wild deer and foxes that were collared as part of ongoing research programs at CRC.

Among the most important techniques we learned were those used to census wildlife. Routine population monitoring is a key component of any sensible wildlife management plan because only through its use can we judge the impact of human activities on wildlife. Yet it is one area which the developing countries are singularly ill-equipped to handle. To remedy this situation, Rudy put us through a grueling regimen. We learned the messy but useful technique of estimating deer populations by counting the number of fecal pellets deposited over a known period and area. We cut long trails in the forests to acquaint ourselves with the simple but superbly effective line-transect sampling method and estimated the wild deer population at CRC with a degree of accuracy that was entirely new to us. Estimating the abundance of a whole range of other species like mice or opossums, which cannot be measured with this technique, was accomplished through the mark-recapture method that we learned.

The well-stocked library and the computer facilities available to us at CRC further expanded our horizons. After we mastered all the techniques, we were split up into smaller groups and during the last two weeks carried out projects to test our skills. The take-home message was simple: These skills were taught using species that were new to us, but when applied correctly, they would work equally well on our native species.

Another fascinating aspect of the program was the continuous exposure we had to wildlife scientists from NZP and elsewhere. Melvin Sunquist and John Seidensticker exposed us to the intricacies of radiotracking studies. Devra Kleiman, Katherine Ralls, and Jon Ballou talked about the practice of conservation genetics and endangered species management. Representatives of the U.S. Fish and Wildlife Service, National Park Service, World Wildlife Fund, and other conservation groups came and spoke to us. Visits to the National Zoo and the National Museum of Natural History showed us what lay behind the magnificent public exhibits in these great institutions.

If you get the impression that it was all dreadfully earnest—all work and no play—you are wrong! With typical American zeal the program combined hard work with lots of fun! Volleyball games and lazy beer parties, visits to historic battlefields, and the madness of Washington on the fourth of July relaxed our strenuous training schedule. The weekend raids we staged on the Front Royal flea market and the K-Mart became legendary! I particularly recall the hilarity of an Indian trainee who discovered that the American shirt he proudly bought in Front Royal turned out to have been made in India! We also teamed up to throw international gourmet dinners that made sober dignitaries from Washington throw caution to the winds, indulge themselves, and risk massive coronaries.

We made new friends and built up professional contacts, using the program as a launching pad. My own case is fairly typical. After completing the course, I renewed my contact with Mel Sunquist, who is now my graduate advisor at the University of Florida. My initial contact with Dave Ferguson, of the U.S. Fish and Wildlife Service, who encouraged me to seek funding from his agency for the predator study in Nagarahole, was at CRC. The excellent faculty which instructs me at Gainesville now has a host of former NZP stalwarts, including John Eisenberg, who headed the Zoo's research wing with great distinction for many years. Whether it is for advice on a project proposal, comments on the draft of a paper, or simply planning a holiday for my family, I know I can count on my NZP friends. They too know that alumni from the program like me are everywhere in the developing world, equally eager to assist them.

The NZP nexus, supported in part by the Friends of the National Zoo, classically demonstrates how zoogoers of the western world can truly sustain the global efforts to save the Sinking Ark. ❑

*K. Ullas Karanth is a doctoral student in the Department of Wildlife and Range Sciences of the University of Florida in Gainesville.*

# Virginia Opossums: Against All Odds

*Susan Lumpkin*
*and John Seidensticker*

*"An Opassum hath a head like a Swine, & a tail like a Rat, and is of the Bignes of a Cat. Under her belly she hath a bagge, wherein she lodgeth, carrieth, and sucketh her young."*

Such was the English explorer John Smith's 1612 description of the Virginia opossum. Accurate, but—what with talk of swine and rats and bags—hardly likely to endear opossums to the reader. Still less endearing is the usual modern sight of an opossum: dead on the side of the road, bearing the imprint of a tire across its back. But to catch a glimpse of six or seven bright-eyed young opossums peering out of a pouch is to be charmed—even though that glimpse is most apt to be caught as their mother scurries away from your torn-up trash sack.

In John Smith's day, North America's only native marsupial lived no farther north than what is now Indiana and Ohio, and not much farther west. Since then, Virginia opossums have steadily expanded their domain. Opossums now occupy some 42 states, including Michigan, Minnesota, and Montana; two provinces, Ontario and British Columbia; and they are still moving inexorably onward. What's more, Virginia opossums thrive in habitats from sea level to over 9000 feet, from virgin forest to urban jungle. Prime habitat for opossums seems to be anywhere they can find something to eat by night and somewhere to sleep by day.

Some of this phenomenal range expansion has been aided by human activities. For instance, people introduced opossums into California around the turn of the century, and the West Coast opossum population boomed. Garbage and newly planted fruit trees inadvertently helped opossums to gain a foothold and survive in cities. But the opossums themselves—opportunists par excellence—deserve all the credit for capitalizing on the opportunities offered by people.

Compared to other mammals, opossums would appear to be distinctly inferior. First of all, they aren't very smart. Biologists commonly estimate a species' intelligence by computing an "encephalization quotient"—a measurement of how that species' brain size compares to the average brain size of all other species with similar body sizes. An EQ greater than one means that the species has a bigger brain than average, and an EQ less than one that it has a smaller brain. Man, with his great intelligence, has an EQ of about 7.5; the raccoon, about the same body size as an opossum, scores about 1.4. So, where does the Virginia opossum stand on this scale? Somewhere between 0.35 and 0.57. As mammalogist John Eisenberg once put it, this critter is playing with about a third of a deck.

Virginia opossums have a fairly limited behavioral repertoire—it's not surprising that they are best known for playing dead—and they usually play alone. Except for the relationships between mothers and their young, which last about three months, no family ties or personal friendships or allegiances to a place clutter the lives of opossums. Even mating, characterized in so many species by elaborate courtship rituals or prolonged pair bonds, is merely a brief, business-like encounter, with males and females controlling their mutual antipathy only as long as it take to get the job done. In one ranking of the complexity of mammalian social systems, the Virginia opossum rated a 2—on a scale that ranges from 2 (least complex) to 20 (most complex).

Individual opossums must also play fast because they don't live very long. In captivity, opossums have been known to live to the ripe old age of

*From backyards to barnyards, the Virginia opossum has followed in man's footsteps across much of the United States. (Photo by Ed McCrea, U.S. Fish and Wildlife Service)*

*Omnivorous opossums take advantage of bonanzas of food, ranging from fruits in season to garbage sacks. (Photo by Ed McCrea, U.S. Fish and Wildlife Service)*

four, but a two-year-old wild opossum is downright hoary; fewer than 10 percent of opossums live much past their first birthday. Some starve to death, some freeze, others succumb to disease and parasites, or are taken by predators, such as owls, dogs, snakes...or people. In fact, hunters, trappers, and most especially, speeding motorists probably kill more Virginia opossums than die from all other causes combined. More than a million opossums are turned into fur coats or collars each year, but as a source of mortality, hunting or trapping for fur is considered minor compared to motor vehicles. Nonetheless, Virginia opossums seem to have no trouble replacing themselves and then some in the short lives allotted to them, even with their intellectual, behavioral, and social shortcomings.

A five-year investigation of Virginia opossums (*Didelphis virginianus*) living, appropriately enough, in the Virginia countryside, provided ample evidence to prove this assertion. The documented history of the opossums of Posey Hollow began in 1980, when John set out to study the native wildlife—raccoons, skunks, and opossums—living on the National Zoological Park's 3150-acre Conservation and Research Center near Front Royal, Virginia. The 1400 acres of Posey Hollow was the study area.

Lying on the western slopes of the Blue Ridge, adjacent to the Shenandoah National Park, the Center's landscape typifies much of the rural eastern United States. Second-growth oak-hickory forest, scrub thicket, old fields, hay meadows and paddocks, and acres of alfalfa interweave on the ridges and hollows. Although the topography is steep, the Center is well-watered. Spring-fed rivers lace the forested hollows, and where drainage is restricted by underlying geological formations, small, muddy seeps appear. Shrub-covered marshes rim the bottoms of the hollows, where forests abut the broad open expanses of the Shenandoah Valley.

Perfect opossum country—most of the time. If anything is absolutely essential to opossums, it is water in springs or streams because it supports the prey—small mammals, insects, snails, crayfish, and other invertebrates—on which opossums rely to survive the summer. But in the hot summer of 1980, one of the worst droughts of the last 50 years hit Posey Hollow. Streams stopped flowing, springs disappeared; by summer's end, water was as scarce as saffron. As a result, the opossum population of Posey Hollow plummeted from 14 to 3 between June and August.

With fall, however, came an abundant crop of fruit—grapes in particular—the opossums' major autumn food resource. By December of that year 13 opossums were living in Posey Hollow and by December of 1982, just two years later, there were 47. Given about 27 months of favorable conditions, the opossum population had increased 15-fold! Clearly these marsupials are no slouches when it comes to breeding.

The marsupial mode of reproduction has often been deemed evolutionarily primitive and therefore inferior to the placental mode of other mammals. But this is an undeserved reputation, based on prejudice (placentalism, if you will): Marsupials are not inferior, they are just different. In the marsupial mode, tiny, undeveloped young are born after a short gestation and then continue to grow and develop while attached to the mother's teats. Marsupial mothers nourish the development of young almost entirely with milk, while placentals give at least equal time to gestation (when young are nourished through the placenta) and lactation. But the end result is about the same: Kids ready to face the world on their own.

The rapid increase in opossum numbers in Posey Hollow suggests that the marsupial system may have a few advantages. Not the least of these is the ability to produce many new opossums quickly. A female opossum is sexually mature the first winter after her birth, when she is only six to nine months of age. In the next nine months, she will rear two litters of young, and then quit; very rarely does a female survive to reproduce a third time. But the litters are large, sometimes numbering as many as 15 young. Posey Hollow females average nine per litter, and 18 young in a year is prolific by anyone's standards.

Nonetheless, female opossums often give birth to many more young than that. After a 12 to 13 day gestation, anywhere from two to 50 babies are born—tiny, translucent "preemies" about the size of a raisin. The embryos are blind and deaf, with undeveloped

but functional circulatory, respiratory, and digestive systems, skeletons of cartilage, and an incomplete central nervous system. Only their front legs and clawed fingers show more than rudimentary development, and these are put to immediate use when the newborn opossum travels from the birth canal to the pouch.

Some of the newborns perish, unable to complete this task, in which they get no help from their mother. In large litters, others, which reach the pouch but cannot find a teat to attach to, will perish as well. Females usually have only 13 teats, and sometimes not all of these are functional. Latecomers to the pouch simply lose out when all the teats have been taken by their faster siblings. However, once attached to a teat (to which they will cling for the next 50 days or so), most young survive until they are are weaned some three months later, all the while enjoying a free ride in the pouch.

The primary advantage of carrying kids around in a pouch is that the mother is a movable nest. All animals with young that require parental care face a similar problem: What do you do with kids when you want to go out to dinner? The most common solution to this dilemma is for the mother to leave young in a nest of some sort (in some cases attended by a "babysitter") while she goes out to forage. But with young dependent on mother's milk, she can range only so far and so long before she must return to feed them; within that time and distance she must consume enough calories to support herself and her offspring, as well as justify the cost, in energy and risk, of making the foraging trip itself.

As movable nests, Virginia opossum mothers need to pay only one-way fares and they don't have to worry about rushing home to feed hungry mouths. They are not tied to any one den, but can rest after a long night's foraging in the closest den available— one that may also be close to the next night's meal. Only for about a week, when young are about to be weaned, does the female leave them in a den while she forages; after this, young again go on foraging trips, now riding on her back or running alongside her. And this allows opossums to take advantage of movable feasts.

Virginia opossums are omnivores, which means they will eat almost anything. Their idea of a feast is a rotting white-tail deer carcass, a noisome pile of garbage, or the fresh bag of kitchen scraps that appears nightly until the "caterer" wises up. In Posey Hollow, a host of earthworms coming to the surface on a humid night may be one night's main course, and the next's a nestful of bird's eggs; a fruiting persimmon tree is an autumn feast. Females bring their young and settle into a nearby den until the banquet is over. But Virginia opossums do not set out in the evening looking only for such unpredictable fare. They are not adapted to weather famines between feasts. Instead they set out looking for something, anything, to eat.

Virginia opossums glean. The bread and butter of an opossum's diet is a diverse array of fairly small food items, eaten indiscriminately as they are found. Each night at dusk, an opossum leaves its den and immediately begins slowly, carefully searching for food. It pokes its nose into the leaf litter and turns up a few snails or a caterpillar. Fingers inserted into the crevice between the ground and a fallen log discover a cluster of insect eggs or a couple of juicy slugs. A garter snake slithers by and suddenly finds itself between 50 sharp teeth, and a crayfish in the tiny spring meets a similar fate. So the opossum usually goes through the night, night after night, a mouse here and a mushroom there, gleaning an area of all that is edible and easily caught, until that small area no longer yields enough food to make the effort worthwhile.

Then the opossum moves. Just like that. Females usually move abruptly, fast and far. In one night a Posey Hollow female with pouch young moved over a mile to a new foraging area, and females may move nearly three miles over several consecutive nights before finding a good foraging site and settling in a new den. The male opossum's movement pattern is different. Males usually glean over a slightly larger area than females do, and gradually and continually shift their foraging range. But all Virginia opossums are lonely nomads that wander throughout their lives looking for greener pastures, always alert to the sudden appearance of an oasis at which they may briefly feast before moving on yet again.

This is how Virginia opossums survive, and thrive. Their lives are not confounded by complexity, but consist of the single-minded pursuit of feeding and breeding. In this pursuit they are remarkably successful, flourishing even as smarter, more social, long-lived species flounder. What seems to matter to Virginia opossums is not how many cards they were dealt, but how they play the ones they got. A movable nest to take advantage of movable feasts is their wild card. ❑

*The opossum mother's movable "nest" provides her offspring with a free meal and a free ride for the first three months of life. (Photo by Fiona Sunquist)*

# The Friends of the National Zoo Annual Report 1987

PULL OUT

JESSIE COHEN/NZP GRAPHICS

# A Time of Achievement

Dear FONZ Members,

It is with great pleasure and great pride that I can again report to you a year of success for The Friends of the National Zoo. Through our educational and membership programs, our contribution of volunteer hours, and our substantial financial assistance, FONZ continues to be the largest private supporter of the National Zoological Park.

Under the visionary leadership of Director Michael Robinson, the National Zoo is evolving into a Biopark that will provide visitors the opportunity to experience and to learn about all of the wonders of the natural world. FONZ is proud to be a part of the realization of this dream. We remain, in our thirtieth year, committed to the founding precepts of the organization — "Education of the general public on matters relating to the increase and improvement of the facilities and collection of the NZP and to foster its use by the general public and schools for educational purposes."

The opening of our new Bookstore in November of 1987 was a giant step toward one of the Zoo and FONZ's shared dreams for the future—to make the Zoo a focal point in the Washington, D.C., metropolitan area for scholarly and popular books and educational materials on nature and the natural world. We see this new Bookstore as a community resource and service, and a vital part of our educational mission. Not only will the Bookstore be an important center for learning in the community, but it will also give visitors ready access to an outstanding selection of books, videos, educational games, and gifts to expand upon the interest stirred by their visit to the Zoo.

The Zoo's stunning new Invertebrate Exhibit, which opened to widespread acclaim in May of 1987, is another example of the fruitful relationship between FONZ and the National Zoo. FONZ volunteers, ever ready to take on new challenges, played an essential role in the functioning of the new exhibit. These volunteers helped the visiting public to understand the world of invertebrates, guided school and other groups through the exhibit, and even assisted the Zoo's invertebrate keepers in their daily chores. FONZ also supported research on invertebrate husbandry techniques, and funded an intern to help develop educational graphics that explain the animals to visitors. And, for FONZ members, an informative, colorful "Guide to the Invertebrate Exhibit" was published as a special section of *ZooGoer* magazine.

FONZ's contribution to the Invertebrate Exhibit was just a small part of our overall support for the Zoo. In 1987, FONZ granted $589,000 to the National Zoo for conservation, research, exhibition, and education programs. Our contribution to these valuable programs has increased dramatically over the last several years, with this year's monies representing a 93% increase since 1983. These funds were used for an unparalleled variety of projects, which were carried out around the world and right here at the National Zoo, supporting research project assistants and aides, research trainees, visiting scholars, field studies, and symposia. Applications for our traineeships and internships came from all over the globe. Among the many projects these students participated in were:

—the golden lion tamarin reintroduction program in Brazil and studies of free-ranging tamarins in the Zoo;

—a field study of parental care and mating systems in the endangered Hawaiian monk seal;

—research on genetics and reproductive physiology of endangered felids in Africa and Sri Lanka;

—development of school programs and live animal programs for HERPlab; and

—a public lecture series.

FONZ's Office of Volunteer and Educational Services also made an enormous contribution to the National Zoo. This office did a superb job in making Zoo visitors better informed through programs developed in conjunction with the Zoo's Office of Education. And our dedicated volunteers made these and many other programs happen by leading tours, observing and recording animal behavior, hand-rearing animals, and beautifying the Zoo.

In 1987, we broke all records for numbers of volunteers and hours of service donated to the Zoo. Six hundred volunteers worked over 49,000 hours in pursuit of one of FONZ's primary goals—"To foster a better understanding of animals, a respect for them, and an appreciation of their real value as wildlife."

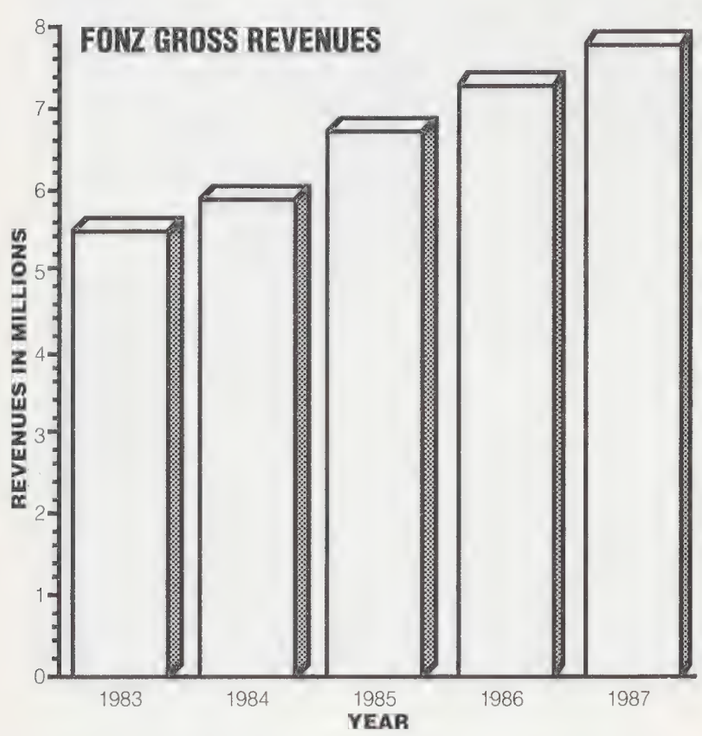
FONZ volunteers led a variety of tours, four of which were new last year: "Animals with Backbones," "Highlights of the National Zoo," "Dinosaur Detective Lesson," and "North American Mammals."

In 1987, FONZ volunteers worked throughout the night to observe the births of the giant pandas. From dawn to dusk for months last summer, our volunteers also followed golden lion tamarins around the Park to ensure the well-being of the Zoo's only free-ranging wild animals and to explain this innovative

"mobile exhibit" to a fascinated public.

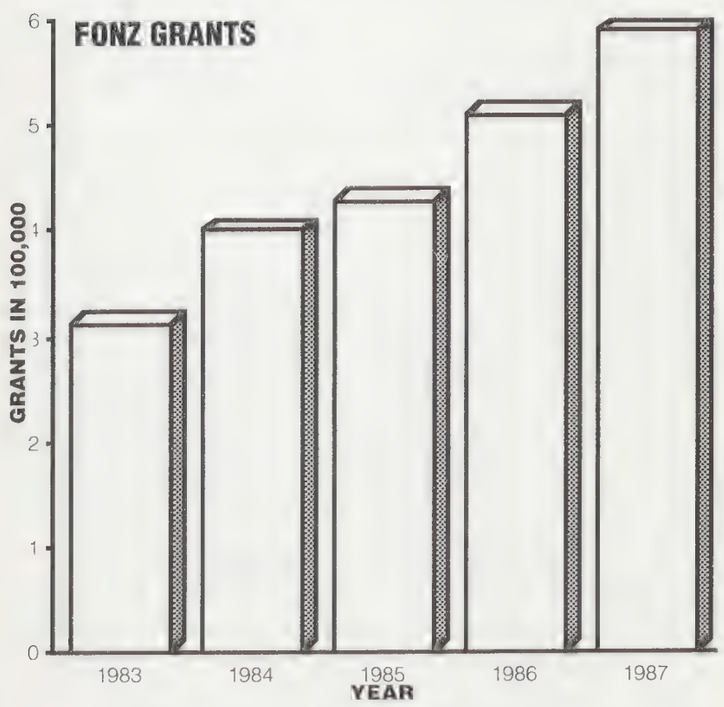
Volunteers hand-reared a variety of newborn animals which could not be raised by their own mothers, including a bongo, a red panda, and a clouded leopard. Volunteers in the "Potpourri" program painted the Glockenspiel animals in the clock tower and installed mosaics, made by students at Walt Whitman High School, in the Elephant House. The ZOOlab renovation (highlighted in the January/February 1988 issue of *ZooGoer*) was also completed with the assistance of ZOOlab and other volunteers.

Of course, what made so much of this possible was the significant achievement of our concessionary operation, encompassing parking, merchandising, and food service. In the continuation of a growth trend that began five years ago, in 1987 we saw more than an eight percent increase in revenues over our record-breaking operations in 1986. Many elements, highlighted below, contributed to this record of success in 1987.




The Parking/ Transportation Department added highly visible parking lot signs and increased the total number of parking spaces available in 1987. Gross revenues in 1987 were an outstanding $700,000. In 1988 we will explore the possibility of variable rate pricing based on length of visitation, in order to make our parking concession even more effective.

Our Food Service Department also achieved record revenues of $2.7 million in 1987, with August being the single highest revenue month at $455,142. A renewed emphasis on quality and variety was reflected in last year's program, including an expansion of our regular menu and the introduction of a breakfast menu in the Mane Restaurant. These enhancements proved successful, and we plan to continue investigating ways to make our excellent service even better.



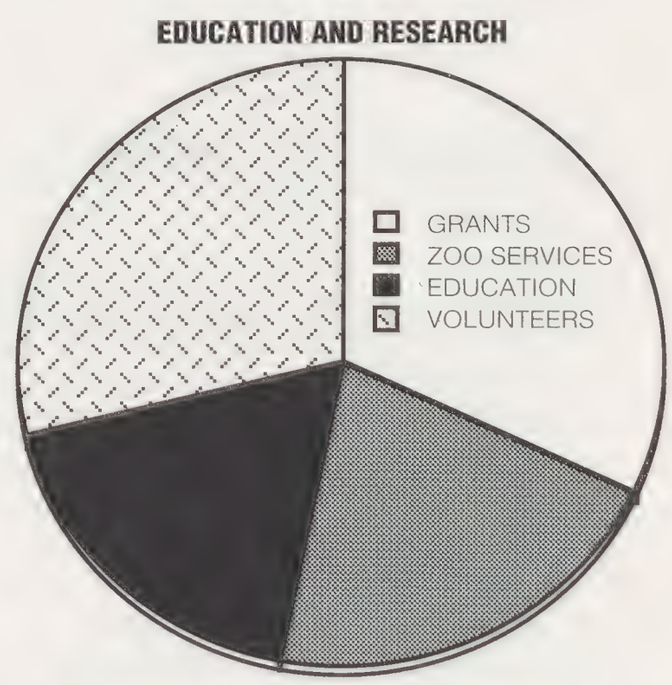

FONZ Food Service also catered some 230 special FONZ and NZP special events and meetings. Among the most notable of these events were ZooNights, the Safari Club Dinner, and the ZooFari Dinner.

The Merchandising Department also experienced another record-breaking year, with revenues of $2.65 million. May was the top month for Merchandising sales, which reached $450,910. We attribute this success primarily to our increased operating efficiency and the expansion of our facilities via the mobile cart program. Finally, the new Bookstore brought in thousands of customers to do their holiday shopping, with total sales far greater than we had anticipated.

FONZ recognizes that the people staffing our concessions and offering information to visitors are FONZ's ambassadors to the public. To ensure the best service to visitors, the Human Resources Department successfully tackled the formidable job of interviewing, hiring, and training the 370 individuals who were part of 1987's seasonal staff. This Department also initiated the "Seasonal Seal of Approval Program," in which employees who went above and beyond the call of duty to provide outstanding service to the public were rewarded with free lunches, gift certificates for our shops, and cash prizes. This program proved very effective, increasing courtesy and service and boosting employee morale, and will be expanded in 1988.

At the very core of Friends of the National Zoo, however, are our loyal members, numbering nearly 50,000 people last year. Members support FONZ in innumerable ways, and to meet their needs, to further stimulate their interest in our great Zoo, and to thank them in some small way, FONZ provided an array of programs and benefits for our members in 1987.

Our Membership Department continued to offer classes, workshops, and a wide range of nature trips and safaris, which are advertised first to our members in the exclusive FONZ publication *Wildlife Adventures*. As in previous years, favorite classes and workshops such as "Summer Safari" and "Zoo Babies" for children were very well attended, and the first-ever "Spring Safari" and "Winter Safari," offered during school breaks, were resounding successes. New parent/child workshops, such as "Prairie Dog Days" and "Animal Diversity," also proved extremely popular, as did the new adult class, "Beginning Nature Photography." Traditional parties for families at Halloween and during the December holidays were also popular with our members. In 1987, FONZ-sponsored trips, led by experienced naturalists, ranged from area outings—the Patuxent River, Cape May, and the Blackwater National Wildlife Refuge—to exotic wildlife safaris—in Kenya, Rwanda, and Brazil.




Membership's new X.Y.Z.—Explore Your Zoo—Club for youngsters from 12 to 16 years of age was also enthusiastically received. In 1987, 90 X.Y.Z. members became junior Zoo aides and class aides.

The Membership Department again hosted ZooNight in 1987. One of our most popular members-only events, ZooNight attracted more than 14,000 members to the "wildest party in Washington." In addition, the fourth annual ZooFari benefit to support the Theodore H. Reed Animal Acquisition Fund drew 400 contributors for a salute to Canada and its wildlife.

The A.D.O.P.T. (Animals Depend on People Too) program, initiated in 1986, continued to attract members, who numbered nearly 1000 at the end of 1987. We believe that programs such as this have great potential for supporting the evolving Biopark, and we would like to expand this concept's scope to encompass landscape, benches, and other special projects at the Zoo, and to enhance the involvement of our supporters in these projects.

*ZooGoer* magazine is a prized benefit of FONZ membership, and the Publications Department strove to provide our members with a magazine of quality. I believe that we accomplished this with a great deal of success, with 1987 seeing the best issues of *ZooGoer* ever. The highlight was the special issue "Cats!" which through beautiful pictures and outstanding feature articles brought the world of cats alive and explained the Zoo's wide-ranging efforts to save endangered wild felids. Our children's publication, "PawPrints," was also made an integral part of *ZooGoer* to continue our emphasis on meeting the needs of our young members. We expect to see an even-better *ZooGoer* in 1988.

I would like to close with an expression of my gratitude to all of the many people who made 1987 such a magnificent success: our volunteers, our members, our staff and board, and most especially Dr. Robinson and his staff for their leadership of the National Zoological Park. It is indeed the Zoo's desire to excel that inspires us at FONZ to excel on the Zoo's behalf.

I served FONZ for three years as president, and reflecting on my term of office I must say that it was an honor and a pleasure to have served. Thank you again for your tremendous support in 1987.

Roscoe M. Moore, Jr.,
D.V.M., Ph.D. Immediate Past President, FONZ

## FRIENDS OF THE NATIONAL ZOO
## BALANCE SHEETS

DECEMBER 31, 1987 AND 1986
(UNAUDITED)

| ASSETS | 1987 | 1986 |
|---|---|---|
| Cash | $ 85,632 | 29,090 |
| Interest-bearing deposits | 373,750 | 1,060,985 |
| Investments | 1,168,757 | 819,390 |
| Accounts receivable | 21,643 | 12,205 |
| Inventory | 776,573 | 303,180 |
| Prepaid expenses | 30,656 | 18,029 |
| Property, plant and equipment, at cost, net of accumulated depreciation of $1,355,286 in 1987 and $1,087,510 in 1986 | 1,091,983 | 655,531 |
| | $3,548,994 | 2,898,410 |
| **LIABILITIES AND FUND BALANCE** | | |
| Liabilities: | | |
| Accounts payable and accrued expenses | 504,074 | 477,806 |
| Note payable | 350,000 | — |
| Deferred revenue—unrestricted | 254,742 | 247,093 |
| Deferred revenue—restricted | 159,855 | 126,219 |
| Total liabilities | $1,268,671 | 851,118 |
| Fund balance—unrestricted: | | |
| Board designated | 872,386 | 794,527 |
| Designated for property, plant and equipment | 1,091,983 | 655,531 |
| Undesignated | 315,954 | 597,234 |
| Total fund balance—unrestricted | $2,280,323 | 2,047,292 |
| | $3,548,994 | 2,898,410 |

JESSIE COHEN, NZP GRAPHICS

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JESSIE COHEN NZP GRAPHICS

# Keeping Watch

*Heidi Hall*

Since the founding of the Department of Zoological Research in 1965, behavioral studies have been a major focus of the National Zoo's scientific work. Results find many different applications: Some studies are compiled and published in scientific journals, while others help to highlight a species' enclosure and lifestyle needs. Designed, executed, and analyzed by Zoo scientists, the success of numerous studies depends to no small degree on the sharp eyes and ears of a dedicated corps of FONZ volunteers.

The ambitious FONZ Behavior Watch program is managed by Jo Anne Grumm. When a researcher requests help, Grumm first tries to get a sense of the project's time frame and specific requirements, then goes to work recruiting and scheduling volunteers.

Now several hundred volunteers strong, the program rolls along like well-oiled machinery. But Grumm recalls accounts of the program's humble beginnings. "The Behavior Watch program started in the '60s, when Mohini, the famous white tiger, was due to give birth. Some people were pulled together to be on a 'Preg Watch.' They got restless waiting for the birth to occur and started writing down what they saw."

The implications of this idea soon became clear. Chunks of data, often painstakingly accumulated, form the bedrock of every research project. Yet in many cases, a solitary researcher cannot hope to collect all the data needed singlehandedly. But what if there were FONZ members who found the idea of "behavior watching" not only a tolerable, but perhaps even an *interesting* way to pass the time? The decision was made to tap this hitherto undeveloped resource—to train and transform what once had been innocent zoo enthusiasts into a band of informed and conscientious behavior watchers.

The first formal behavior watch occurred in November 1972, when the newly trained volunteers used checksheets to record the nocturnal behavior of the giant pandas, under the direction of NZP scientist Devra Kleiman.

*Volunteer Steve Frank uses a checksheet to record his observations of the Zoo's sea lions. (Photo by Judy Wulf, NZP Graphics)*

An invaluable tool for researchers, the program has changed greatly since its early days, expanding to incorporate everything from the maternal behavior of bongos to the mealtime preferences of worm-eating warblers. Watchers in years past have recorded not only the famed giant panda matings and pregnancies, but also the activities of some of the Zoo's less publicized members:

- A six-month study initiated in December 1984 tracked the social development of a newborn gray seal (*Halichoerus grypus*) through the stages of nursing, weaning, and independence. Gray seal pups observed in the wild undergo a period of contact shyness after weaning, and new Zoo pup "Kara" was seen to experience a similar period of self-imposed isolation following a normal weaning at age three weeks. Watchers marked Kara's slow emergence from this period of shyness, noting behaviors such as "fore-flipper stroking" "following," "nosing," and other types of seal social play.
- Army-style "night glasses" were used in a nocturnal study of the red pandas (*Ailurus fulgens*). Powered by batteries, the glasses provided a greenish, TV-like image in almost total darkness. Sharing one set of glasses between them, watcher pairs checked the red panda's location, activity, and feeding

behavior during two-to-three hour shifts. Zoo researchers undertook the study in an effort to determine more about the red pandas' feeding behavior and possibly introduce other foods to supplement their primarily bamboo diet.

• Participants in a mating watch of the dorcas gazelles (*Gazella dorcas*) observed the following courtship routine: The male approaches the female and strokes her hind-leg with his foreleg, then sniffs her. The female responds by urinating; the male reciprocates by sampling a mouthful of her urine, engaging in a display of "lip curling" or "flehmen". As watcher Lee Miller explained, "The male gazelle is using the Jacobson's organ located in the top of his mouth to determine whether the female is actually in estrus." Watchers had been briefed on what type of behavior to expect in these pre-mating rituals; to his pleasure, Miller found "the gazelles followed the book."

Armed with stop-watches and binoculars, watchers strive for accuracy and precision as they mark the frequencies and directions of behaviors during a given time period on check sheets. In some studies, behavior must be coded as frequently as every 60 seconds; in others the watcher may record data only every quarter of an hour. But how do all these scattered markings ever emerge as anything the rest of the world would care to hear about?

The process works roughly like this: Animals provide spontaneous behavior; volunteers provide the observations and data; and NZP researchers provide, in the words of one behavior watcher, "the drudgery of analysis." As researching minds focus in on the patterns and trends within the masses of recorded behavior, a gleam of understanding will now and then emerge as previously unrecognized relationships grow clear.

Studies of juvenile dorcas gazelles begun in 1986 and continued over the summer of 1987 serve as a case in point. Native to areas of northern Africa and eastern Asia, the dorcas is a delicate, goat-sized member of the gazelle family. Each Saturday, while most of us were just lifting that first cup of coffee to our lips, behavior watchers were recording such gazelle play behaviors as "butting heads," "kicking forelegs," and "shoulder pushing" in a most unplayful and professional manner.

Each minute of recorded time presented the scientists with copious data to assimilate. Calves were observed each Saturday, from birth through 12 weeks of age, amounting to 144 hours of observation on each calf. Researcher Kaci Thompson reported that she received "about 760 'scan samples' a day...from that I can figure out what percentage of time is spent on each activity, and the frequency of each activity. I get a very accurate breakdown of exactly what was done and when."

Thompson's dorcas gazelle study is part of her ongoing research on the function of play behavior in ungulates. Drawing on "skill development theory," Thompson believes that different types of play behavior help the young develop skills they will need as adults. Thus when watchers mark down antics such as "running" or "hindleg kick," they may be observing play behavior that will ultimately enable adults to avoid hungry predators; similarly, aspects of social play, such as "butting" or "head sparring," may prepare male calves for the fighting they must someday engage in to obtain mates or territory. Indeed, Thompson's research specifically addresses play behavior in juvenile males and its relationship to fighting and mate acquisition in adults.

Thompson examined several species, each with its own unique mating system and set of courtship patterns. Dik-diks (*Madoqua kirki*) are highly monogamous animals; adult males defend their territories from other males but otherwise little fighting takes place. Sable antelope (*Hippotragus niger*) are at the other end of the spectrum, with adult males engaging in fierce competition for access to females. Sables have none of the stability of monogamy—to fight is to rule a territory, and the small number of victorious males are visited by herds of 10 to 15 females. Males who fail to dominate in fights have no access to mates at all and leave no offspring for the season. Dorcas gazelles fall somewhere between the patterns of

JESSIE COHEN. NZP GRAPHICS

*FONZ volunteers helped researchers gather thousands of hours of data on the play behavior or young ungulates, including dorcas gazelles (above) and sable antelope (next page).*

DANIEL ANDERSON

dik-diks and sable antelopes. Males do fight, but the groups of females won by the victors are smaller, ranging from three to five.

It would seem that the ability to dominate in fights is a crucial skill for sable antelopes to develop, not quite as important in the world of the dorcas gazelle—and relatively unimportant in the world according to dik-diks.

With the theory of "skill-development" in mind, one might expect to see a corresponding difference in the juvenile play of these three species, and indeed, a preliminary look at data gathered during the summer watching sessions seems to bear this out.

"The juvenile sable antelope males spend a lot more time 'play-fighting'—there is much more play overall, and the play behavior is more complex, more involved, with more different types of behaviors shown," Thompson reported. Dik-diks show less play behavior—and less complex play behavior—than the sables. Dik-dik play is more likely to be solitary, while sables tend to play in groups. As might be expected, the play of dorcas gazelles falls somewhere in between.

At the end of the observation phase of a project the researcher usually holds an informal presentation for the behavior watchers, during which he or she outlines the directions in which the data may be pointing. As one dorcas gazelle watcher remarked, "It's a good time to get a feel for the larger picture—and it's nice to know what became of all those hours!"

The dorcas gazelle studies were clearly angled toward basic research—knowledge gained for knowledge's sake. Other behavior watches yield results with practical applications at the Zoo. Some observers track mating behavior, or the course of a pregnancy, while others seek to address issues of animal management. Regardless of a project's purpose, however, the services offered by behavior watchers are often indispensable. But what sort of rewards do behavior watchers receive in return?

The knowledge that they have made a contribution to the advancement of science or to the refinement of an exhibit can be gratifying, yet for many, the real reward is the chance to experience an animal or species in a very personal way. The need to focus one's attentions on the actions and reactions of one other living creature can leave a watcher with a renewed sense of wonder about the living creatures that share our earth.

As gazelle watcher Kathy Kelly put it, "I really think that if you took the time to watch any animal consistently, you'd begin to *like* that animal and learn to understand and respect it." And if it is indeed true that an object cannot be observed without itself changing as a result of that observation, then the converse is perhaps also true: that a watcher cannot observe and not be changed by the experience as well.❑

*Writer Heidi Hall was a FONZ Publications intern.*

# Wildlife Wonders of Australia

*Barbara Sleeper and Michael Hutchins*

*Red-bodied swallow-tail butterflies in the wild. (Photo by Michael Hutchins)*

When novelist Marcus Clarke settled in Australia during the 19th century, he described his new home as "a fantastic land of monstrosities, trees without shade, flowers without perfume, birds who cannot fly, and beasts who have not learned to walk on four legs." His list could also have included mammals that lay eggs, lizards without legs, and frogs that carry their eggs in their stomachs. With a diverse rugged landscape of spinifex grasslands, coastal dunes, salt and freshwater marshes, eucalyptus and acacia woodlands, rainforests, and a vast central desert, Australia provides a haven for some of the world's most unusual wildlife.

For starters, take the monotremes—a primitive group of mammals that seems to straddle the line between reptiles, birds, and mammals. Including only one species of platypus and two species of echidnas, monotremes lay eggs and have a single ventral opening, or cloaca, that serves for both reproduction and elimination of wastes. But monotremes have fur, lactate, and in most other features are clearly mammals, though specialized ones. Monotremes are found only in Australia and New Guinea, and their evolutionary history is obscure. The oldest platypus fossil yet uncovered is only about 10 million years old, and appears very little different from the living form.

With thick, waterproof fur, a duck-like bill, webbed feet, and a beaver's paddle-shaped tail, the platypus is adapted to a semi-aquatic existence in a variety of habitats in eastern Australia. The streamlined adults are toothless, thriving on a diet of "yabbies" (crayfish), earthworms, and other small

prey which they gather from the mud of ponds and slow-moving streams and then store in cheek pouches until the prey can be consumed at the water's surface. Recently, German and Austrian scientists discovered that platypus may locate prey by sensing electrical fields—the duckbill may actually act as a sophisticated antenna, which detects weak electrical signals emitted by the bodies of crayfish, frogs, and other small animals.

The short-nosed echidna, on exhibit in the Zoo's Small Mammal House, is widely distributed in Australia. Often called a spiny anteater, the echidna has also been confused with a porcupine because of its covering of long spines. This mobile ball of bristles spends its time fossicking in ant and termite nests with its long nose and sticky tongue. When frightened, an echidna either curls up into a ball to expose only its sharp radiating spines, or quickly digs into soft substrates, leaving only the spines above the earth's surface.

Australia and New Guinea are also home to about two-thirds of the world's living marsupials, some 171 species of "pouched mammals." The most striking feature of the marsupials is that young are born in an embryonic condition—tiny, naked, and blind, with the hind limbs and tail still undeveloped. Although marsupial gestation periods range from 12 to 44 days, in all of the species studied so far, active infant development occupies less than 11 days of the time in the uterus. The young complete their development while being carried by their mothers, usually in an external pouch. (Some species of marsupials, such as numbats, have only vestigial pouches or none at all.)

Australian marsupials have evolved to occupy most of the ecological niches that placental mammals occupy in the rest of the world. Occurring in all of Australia's diverse habitats, marsupial species range from tiny insect-eating planigales that weigh in at less than an ounce to the large herbivorous kangaroos at up to 200 pounds. In between are a variety of omnivores, such as the bandicoots and bilbies which eat plants as well as insects and small vertebrates.

The marsupial carnivores are a fascinating but poorly studied group. Australia once supported a large carnivore fauna, including a marsupial "lion" that probably preyed upon species of kangaroos even larger than the contemporary ones. This megafauna became extinct during the late Pleistocene but the largest modern marsupial carnivore—the thylacine or Tasmanian wolf—has disappeared only recently: The NZP actually exhibited thylacines in the early years of the century.

There remains, however, a diverse group of carnivores living in all of Australia's terrestrial habitats, most of them members of the dasyurid family. The majority of the dasyurids are small—50 percent of the species boast weights no more than 3.5 ounces—and with long, thin snouts resemble shrews in appearance and behavior. And like shrews, their diets include insects, earthworms, spiders, small lizards, and even flowers and fruit, in varying proportions.

*Kookaburra or giant kingfisher. (Photo by Jessie Cohen, NZP Graphics)*

Others, however, are sizable predators, for instance the quoll, or tiger cat, and the notorious Tasmanian devil. The black-and-white devil is not very efficient at capturing active prey, and appears to live largely on carrion, sheep, and one species of wallaby. Like hyenas, devils possess very powerful jaws and sharp teeth, well-suited for breaking and chewing bones.

Other dasyurids are famous for their unusual life cycles. Males of seven shrew-like species of *Antechinus* and two of *Phasogale* live life in the fast lane. In the brown antechinus from the rainforests of Queensland, all males become sexually mature at precisely 11 1/2 months of age. Mating occurs during one frenetic two-week period in the Australian summer, during which males and females may copulate for up to 12 hours a day. Soon after, the exhausted males die, leaving the only representatives of their sex in utero. Females live longer, up to three years, but rarely produce more than two litters in their lifetimes.

The koala, of course, is one of Australia's most familiar and best-loved marsupials. From warm sub-tropic to cool temperate regions, koalas can be found anywhere that eucalyptus

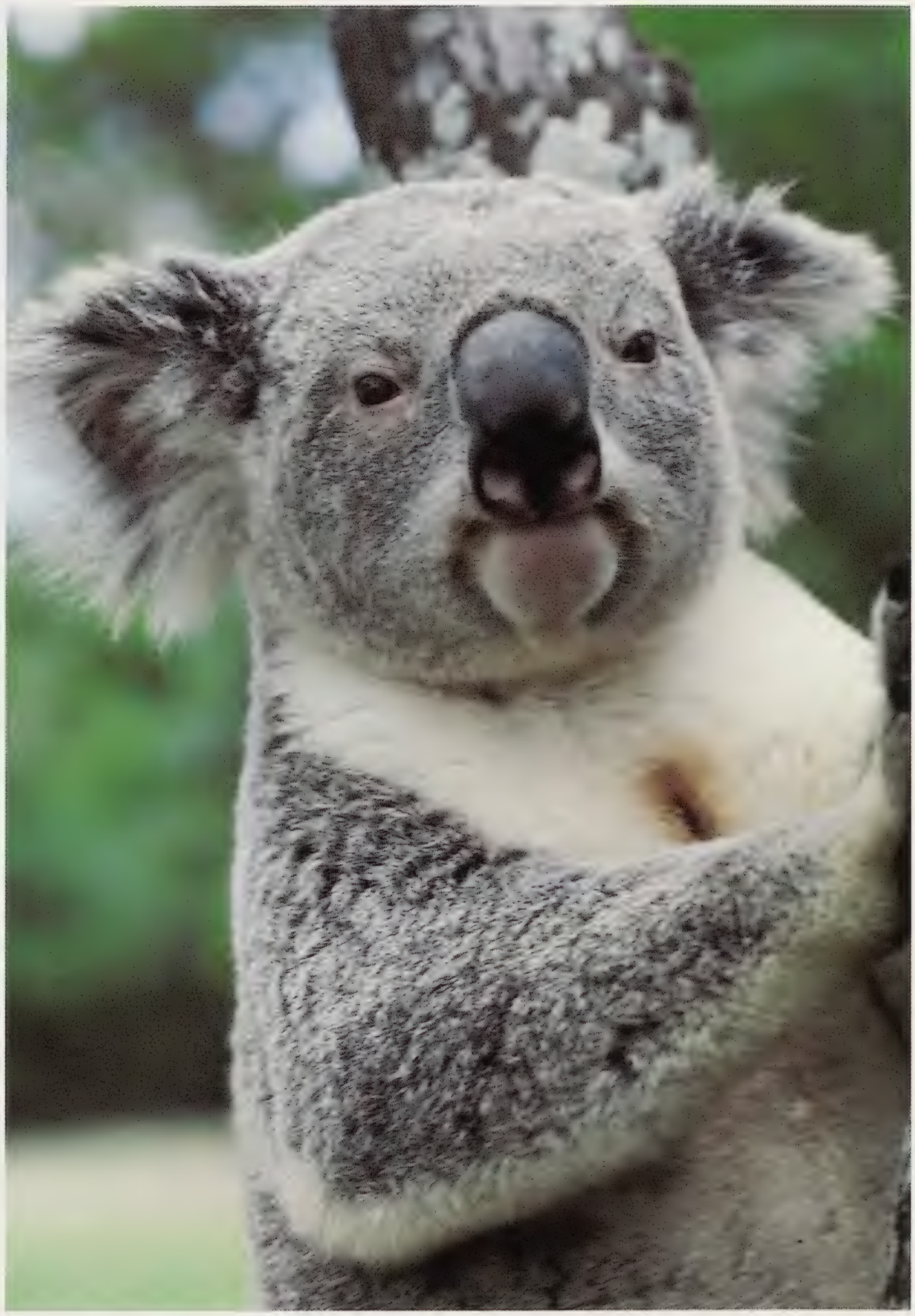
*Bearded dragon in the wild. (Photo by Michael Hutchins)*

thrive: The bulk of the koala's diet is eucalyptus leaves, koalas live high in eucalyptus trees, and they get most of their water from the leaves (roughly translated, the word koala means "he who does not drink"). Koalas even smell strongly of eucalyptus! But as a result of their low-protein leafy diet, koalas must conserve energy. They snooze away the daylight hours and more, sleeping up to 18 hours each day, and when koalas are awake they move slowly and only as far as they must to eat more than a pound of leaves each night.

Perhaps the best-known of all marsupials is the kangaroo—Australia's national animal. "The" kangaroo, however, is only one of about 55 species of kangaroos and wallabies (macropodids) that live in habitats from the inland plains to the tropical rainforest. All of the macropodids are relatively large herbivores with the distinctive kangaroo shape and hopping locomotion. The kangaroo on exhibit at the Zoo is the red kangaroo, which may weigh up to 200 pounds and stand nearly seven feet tall. Affectionately called "big red," it inhabits mulga scrublands, arid woodlands, and open grasslands. Adult females are smaller than males and are called "blue flyers," a reference to their speed and bluish-gray color.

Not all of Australia's mammals are monotremes or marsupials. Australia boasts a diverse bat fauna, including enormous flying foxes with wingspans that may exceed four feet and eerie ghost bats with translucent wings. Neither is Australia free of rats, several species of which are native. But the majority of Australia's placental mammals were introduced by European settlers. Sheep, horses, donkeys, cattle, water buffalo, rabbits, goats, cats, dogs, foxes, pigs, and even camels now reside in Australia. Many of these exist as both domestic and feral populations. For instance, travelers to the outback may wonder if they've suddenly been transported to the Middle East when they catch their first glimpse of a dromedary camel browsing in the red-sand desert. Imported from Afghanistan over a century ago to help explore and settle the continent's vast interior, the feral dromedary population numbers over 300,000 and now seems as much a part of the arid landscape as spinifex grass and dingoes.

Australia is home to diverse bird life—over 700 species of birds occur there and some 500 them occur only in Australia. Among the most fascinating are the nine species of bowerbirds. Using grass and twigs, male bowerbirds construct pergola-like structures where they hold court to attract females for mating. In several of the species, males decorate these bowers with fruits, berries, and other assorted items. Seemingly fixated on the color blue, the satin bowerbird supplements naturally occurring blue items with bits of candy wrappers, broken glass, and clothes pins. The forest-dwelling golden bowerbird elaborates its bower into twin maypole towers up to nine feet high! Interestingly, when comparing the bowerbird species, males with drab plumage tend to build more ornate bowers than do more colorfully-plumed males.



*Koala in the wild. (Photo by Michael Hutchins)*

Another intriguing group are the megapodes or mound-builders, including the brush turkey, a species on exhibit at the Zoo, and the mallee fowl. Male mallee fowl build huge natural "incubators" by excavating a pit, filling it with vegetation, then topping it off with a four-foot mound; after many years of use, the mound may reach 16

feet in diameter. Several females lay their eggs in one male's mound and the heat of the fermenting vegetation keeps the eggs warm. Males maintain a constant temperature for the eggs by digging holes in the mound or changing its shape. After hatching, young tunnel out of the mound to the surface.

The emu, which adorns the Australian coat of arms, is the second largest bird species in the world. It is also one of Australia's largest herbivores. Weighing as much as 100 pounds, emus do not fly but they can flee from danger at speeds up to 30 miles per hour. Other birds unique to Australia include the frogmouth and the night parrot, both of which are nocturnal, the black swan, a lyrebird, and the sulfur-crested cockatoo.

Reptiles abound in Australia. About 250 species of lizards, about 140 species of snakes (many of them venomous), and two crocodiles make their homes in Australia's diverse habitats. The famous frilled lizard startles potential predators by opening its mouth and erecting a flap of skin around its head; running upright on its hind legs, it can easily outdistance a man over a 50-yard course. The desert-dwelling perentine goanna, on the other hand, is formidable without trying—at a length of up to nine feet, this huge lizard approaches the size of the legendary Komodo dragon of Indonesia. And the rainforest's enormous pythons—some reaching lengths of 20 feet—startle the prey they lie in wait for. Australia also supports an interesting variety of amphibians. One of the most unusual is the gastric brooding frog. This rare amphibian swallows its fertilized eggs and apparently shuts down the digestive functions of its stomach. Following hatching, up to 15 fully-formed frogs emerge from the mother's mouth!

Being the largest island in the world—so large it qualifies as a continent—Australia including Tasmania has nearly 17,000 miles of coastline. The coast and surrounding shallow sea provide rich habitats for thousands of varieties of fish and other marine organisms. Sea turtles, including the green, leatherback, loggerhead, and hawksbill, frequent the coastline. The sea grass meadows of Shark Bay in Western Australia are home to the rare dugong or sea cow, and Australian fur seals, sea lions, and tiny fairy penguins breed on the rocky islands of Bass Strait. Australia's greatest wildlife wonder may be the Great Barrier Reef.

*Scrub or brush turkey. (Photo by Michael Hutchins)*

Created by billions of coral polyps—microscopic marine animals—the reef extends some 1,200 miles and encompasses an area of 100,000 square miles. The reef is home to about 2,000 species of colorful fish, giant manta rays, whales, dolphins, giant clams, and numerous sponges and other invertebrates. The reef's coral atolls are breeding grounds for massive colonies of seabirds. And lurking among all this splendor are great white sharks.

Australia has been isolated from other land masses for over 45 million years. In this time, evolution produced some strange and wondrous life forms. Even the father of modern biology, Charles Darwin, expressed a special sense of wonder at Australia's fauna. Referring to Australia he wrote: "I had been lying on a sunny bank, and was reflecting on the strange character of the animals in this country as compared with the rest of the world. An unbeliever in everything beyond his own reason might exclaim, 'Two distinct Creators must have been at work; their object, however, has been the same, and certainly the end in each case is complete.'" ❑

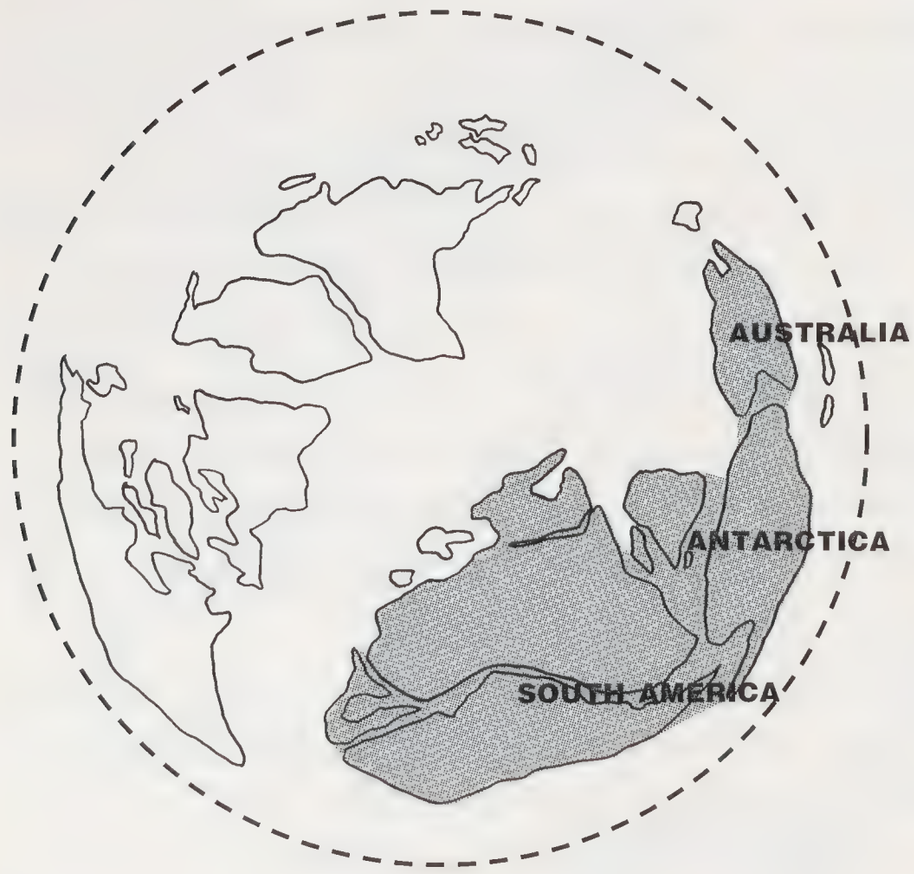
*Barbara Sleeper is completing a Ph.D. in animal behavior at the University of Washington and writes often on natural history. Michael Hutchins is a conservation biologist with the New York Zoological Park.*

# The Mighty Marsupials

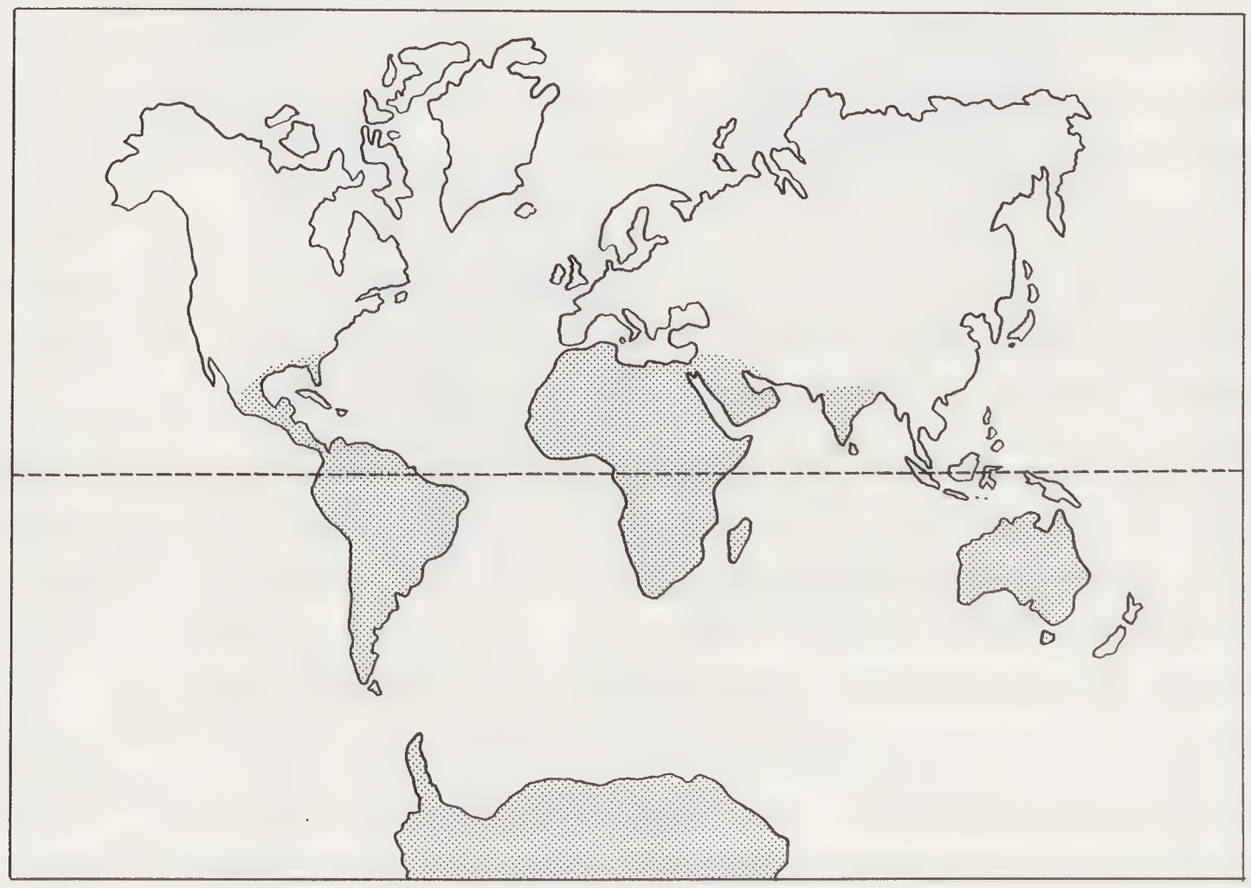
You may have seen a Virginia opossum in your backyard or along a road at night. These animals are very common throughout much of the U.S. and are even spreading into new areas. Virginia opossums are North America's only native marsupials. Marsupials are mammals—animals that have fur and feed their young milk. But at birth, young marsupials are much smaller and more helpless than babies born to most other kinds of mammals, like raccoons and people. These tiny infants mostly develop outside their mother's body, usually in a pouch called a marsupium on the abdomen. In most other mammals, known as placentals, young develop inside the mother's body. The world's most famous marsupials—kangaroos and koalas—come from Australia, so you may be surprised to learn that many marsupials also live in South America.

Do you know where the first marsupials lived? Scientists have been trying to find the answer to this question by studying fossils, remains of plants and animals preserved in stone for millions of years. The clues they have found from fossilized bones may surprise you. The oldest marsupial fossils found so far are from animals that lived millions of years ago in North and South America!

Back then, North and South America were separated by ocean. Both continents had many different species of marsupials, including carnivores (meat-eaters), insectivores (insect-eaters), and frugivores (fruit-eaters), but all of the North American species mysteriously died off. Placental mammals then took over the marsupials' places in the environment. Marsupials in South America continued to evolve along with the pla-




*If you could have viewed the world from space millions of years ago, this is how the Earth's continents would have looked. Australia was part of a supercontinent at the bottom of the world called Gondwanaland. Notice how close South America is to Australia—you can see that animals might easily have traveled back and forth across continents.*



*Today, the Earth's continents are in very different positions. Australia is completely separate from the other continents and it continues to move a little each year. The theory of moving continents is called continental drift. (Drawings by Sriyanie Miththapala)*

centals. Some very large marsupials that looked like hyenas and saber-toothed tigers lived in South America.

About five million years ago, North and South America became connected by a "land-bridge" formed by Central America. South America was no longer isolated and North American mammals, such as species of cats, dogs, bears, and deer, went south to colonize the new territory. About the same time, many South American marsupials and placentals went extinct. But small, insect-eating marsupials survived. Today there are about 90 different species in South America, and one—the Virginia opossum we see in our area—has moved back north to successfully colonize North America.

*Male (left) and female (right) red kangaroos. (Photo by Jessie Cohen, NZP Graphics)*

If the first marsupials lived in North and South America, you may wonder how marsupials ever got all the way to Australia. The answer is that marsupials probably reached Australia by crossing Antarctica from South America! How was that possible? Until about 45 million years ago, South America, Antarctica, and Australia were part of one huge piece of land called Gondwanaland. Some marsupials living in South America were able to spread across the Antarctica part of Gondwanaland, which was then covered with forests instead of ice. Scientists know marsupials lived in Antarctica because the only fossil mammal ever found there is a marsupial. From Antarctica, the marsupials moved into the Australian part of Gondwanaland.

At about the same time in the earth's history, before any placental mammals got there, Australia separated from Antarctica and became an isolated island. The marsupials continued to evolve into new species and today there are about 260 different species of marsupials in Australia. Many occupy the same roles in the environment that placentals take in the rest of the world.

Some Australian marsupials appear very similar to familiar placental mammals. For instance, there is a marsupial "mole" that burrows underground, and many different marsupial "rats" and "mice." There are gliders that glide from tree to tree like our flying squirrel, and even a dog-like predator called a thylacine, which sadly may now be extinct. Other Australian marsupials do not resemble placental mammals but they perform similar tasks. The koala, for instance, eats only leaves, much like sloths and some monkeys. Red and gray kangaroos graze open areas like bison, horses, and antelope do in other parts of the world.

When Europeans began to colonize Australia about 200 years ago, they brought with them domestic placental mammals. Cattle, sheep, donkeys, and rabbits gobbled up fragile plant life, changing or destroying the habitats that marsupials have been adjusting to for millions of years. However, in Australia as well as in North America and Europe, people are studying marsupial biology and trying to save these remarkable creatures. Scientists at the National Zoo, for instance, are studying the habits of marsupials like the sugar glider and the ring-tail possum.

The marsupials have undergone many changes since they started out millions of years ago in North America—and they are still doing so today. One thing is for sure: The marsupial story is amazing.

— *Howard Youth*

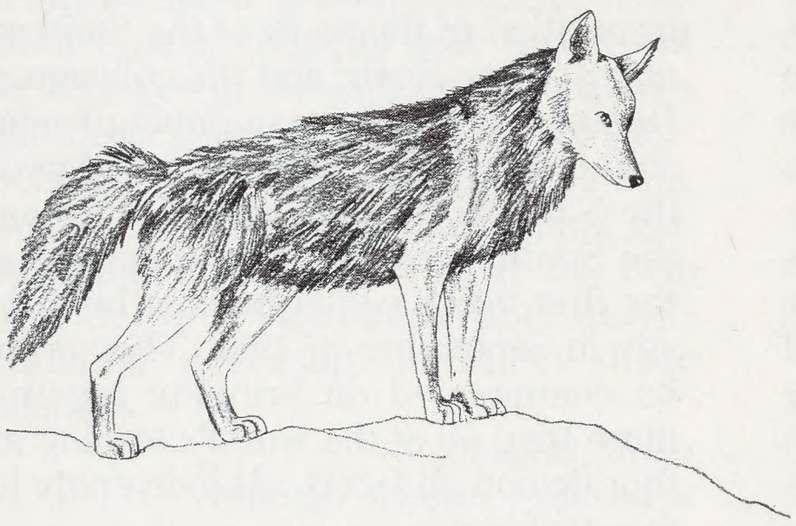
- Further reading: *Where the Forest Meets the Sea* by Jeannie Baker. Greenwillow Books, New York. $11.95.
- *Tasmania: A Wildlife Journey* by Joyce Powzyk. Lothrop, Lee & Shepard Books, New York. $11.75
- *A First Look at Kangaroos, Koalas, and other Animals with Pouches* by Millicent E. Selsam and Joyce Hunt. Walker & Co. New York. $12.95.

# SAME, YET DIFFERENT

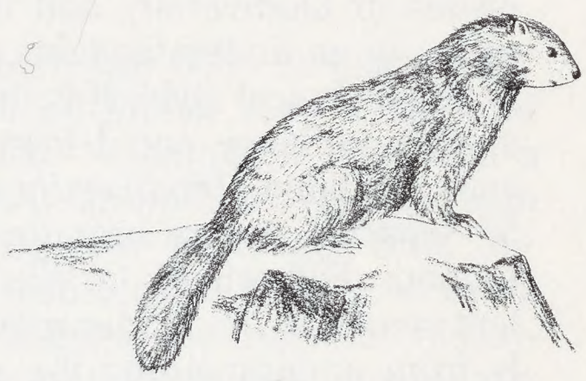
*by Howard Youth and Kathryn Lehnhardt*
*Drawings by Sriyanie Miththapala*

Australian marsupials often look very different from mammals found in other parts of the world, but their habits may be very much the same. For example, the Australian koala lives in trees and eats leaves. Its counterpart (an animal with similiar habits) from South America is the sloth, also a tree dweller and leaf eater. Draw a line to some Australian mammals with their counterparts in North America.

**NORTH AMERICAN MAMMALS**

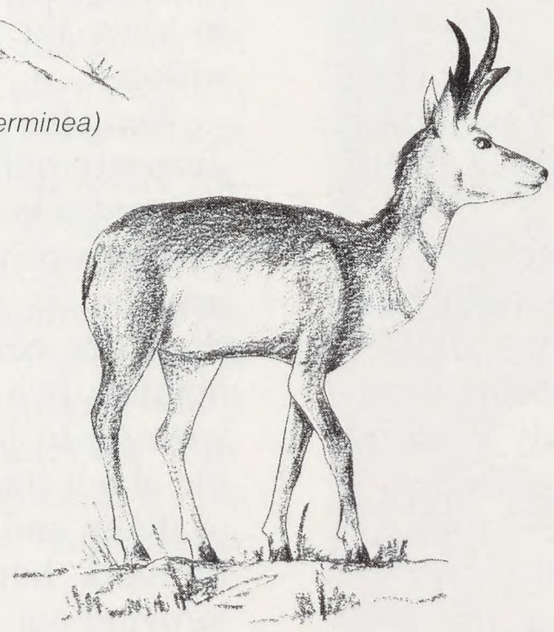


**COYOTE** *(Canis latrans)*



**WOODCHUCK**
*(Marmota monax)*

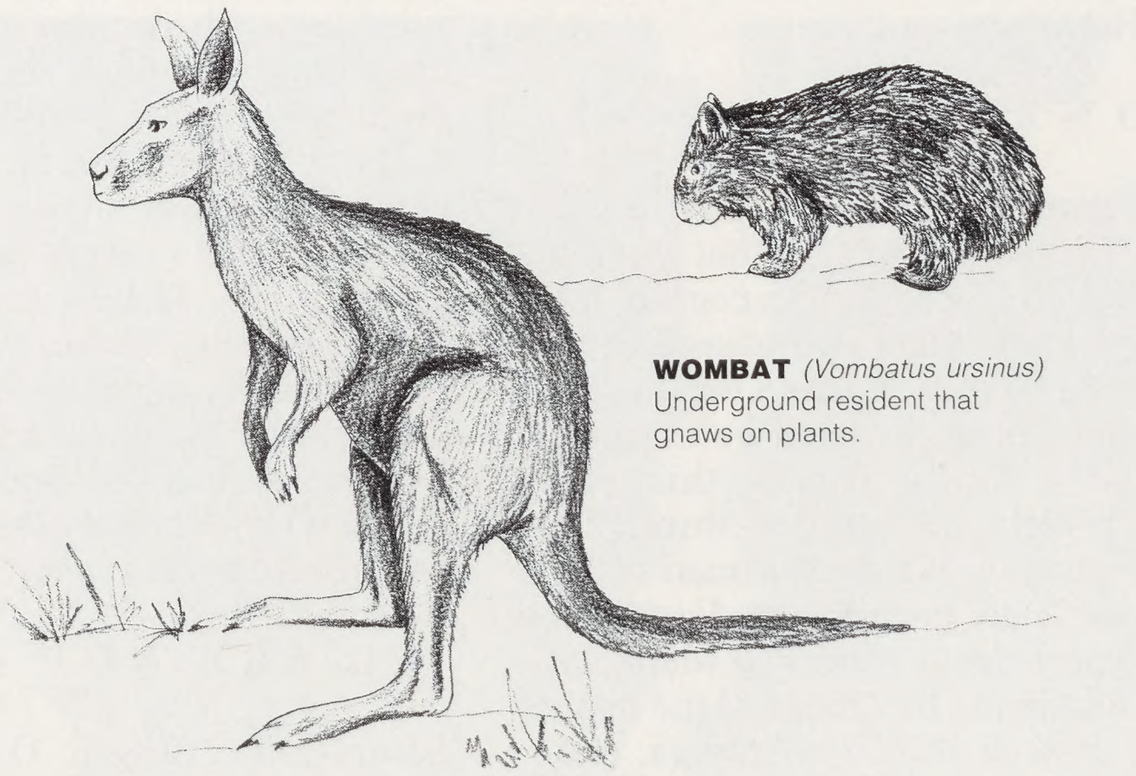
**ERMINE** *(Mustela erminea)*



**PRONGHORN ANTELOPE**
*(Antilocapra americana)*

**AUSTRALIAN MAMMALS**

**TIGER QUOLL** *(Dasyurus maculatus)*
Forest dweller that spends most of its time on the ground hunting small animals.



**WOMBAT** *(Vombatus ursinus)*
Underground resident that gnaws on plants.

**RED KANGAROO** *(Macropus rufus)*
A plains grazer that lives in large groups.

**THYLACINE** *(Thylacinus cycnocephalus)*
Large meat-eater that lives in open woodlands

**ANSWERS**: thylacine-coyote; red kangaroo-pronghorn antelope; wombat-woodchuck; tiger quoll-ermine.

# N O T E S A N D N E W S

## NEW AT THE ZOO

Once again, the coming of spring heralds the arrival of many Zoo newborns. Twins were confirmed in the spectacled bear den by keepers who heard the infants' soft cries. Look for the roly-poly cubs later this season when they are old enough to venture outside. The Zoo's bat colony in the Lion/Tiger Building boasts the arrival of a newborn hammer-headed bat. The baby belongs to the largest bat species on exhibit and, with close observation, can be seen wrapped in its mother's wings. Other notable births included two golden-headed tamarins, a Goeldi's monkey, and a pygmy marmoset. Be sure to see the newly hatched African pancake tortoise in the Reptile House.

Newly arrived from Guam is the Micronesian kingfisher on display in the Bird House.

## FONZ / ZOO NEWS

•An appreciation ceremony for 100 Walt Whitman High School students was held on March 20 to recognize their creative energy and enthusiasm in producing 64 wildlife mosaics for the Zoo's Elephant House. Initiated by Curator of Mammals Edwin Gould, this mammoth project was guided through its many steps by Walter Bartman of Walt Whitman's art department. Each panel in this permanent gallery of wildlife artwork highlights the giants of the animal world. Fifteen FONZ volunteers, under the leadership of Lee Sutherland, collaborated in the final preparation and mounting of the display.

•National ZooFari '88, FONZ's benefit to support the Theodore H. Reed Animal Acquisition Fund, celebrates the distinctive culture and wildlife of Australia. Mark your calendars for May 26 when you'll hob-nob with famous Australians such as echidnas and kookaburras, enjoy an authentic outback barbeque, and dance to live music under the stars. Tickets for ZooFari are $75 per person. For your invitation or further information please call 332-WILD.

•In early May, four giant spider crabs will debut in a new aquatic exhibit donated by All Nippon Airways. These amazing giants of the deep, with leg-spans which may grow to reach 9 feet, are seldom featured in zoo collections. Curator of Invertebrates Jaren Horsley refers to the Japanese spider crabs as a Rembrandt species, and has used these natural masterpieces as a focal point of the Invertebrate Exhibit. The 3500-gallon marine tank designed to house these enormous crustaceans permits children and adults an exciting, close encounter at eye level.

•The 8th Annual National Zoo Symposium for the Public will be held on the evening of April 8 and all day on April 9 in the Education Building Auditorium. The theme of this year's program, which is funded in part by FONZ, is "Culture: The Missing Element in Conservation and Development." Guest speakers will examine the human dimensions involved in conservation problems and economic development. Cultural elements will be discussed as a vital component of solutions to the many problems now facing nature conservationists. Tickets are available for $15 per person, $10 for students. Please make checks payable to the National Zoological Park. Mail to: Office of Public Affairs, National Zoological Park, Washington, D.C. 20008. For further information, please telephone 673-4840.

## WE ARE NOT ALONE!

*Biodiversity.* 1988. E .O. Wilson (ed.). National Academy Press, Washington, D.C. 550 pp. Paperbound $19.50. Hardbound $32.50.

I don't recall exactly when I first heard or read the term biodiversity but I suspect it was only within the last decade. Few terms or their associated concepts have moved so quickly from the pages of obscure biological journals to the front pages of newspapers throughout the world as has biodiversity. A word that can't be found in my 1976 edition of *Webster's New Collegiate Dictionary* and yet it is the most serious biological challenge confronting our species today! Biodiversity is the abbreviated form of biological diversity and simply refers to the number of species or kinds of living organisms with which we share this planet. Remarkable as it may sound, we do not know with any certainty how many unique biological organisms exist. Estimates vary from a conservative 1.4 million to more than 30 milllion based upon extrapolation of the work of the Smithsonian's Terry Erwin and his colleagues. Demonstrating their continuing leadership in the field of scientific endeavor, the National Academy of Sciences and the Smithsonian Institution sponsored the first major conference on biodiversity in September of 1986. They are to be commended on bringing together more than 60 of the world's leading authorities on all facets of biodiversity for this conference.

This volume presents the complex issues of biodiversity and its maintenance in an understandable and largely non-technical style. It is intended for a wide audience and I found it to be very readable. *Biodiversity* consists of 57 separate papers organized into 13 sections. Following E.O. Wilson's excellent synopsis, the reader moves logically from understanding the magnitude and significance of problems presented by the loss of biodiversity through sections on research, monitoring, restoration, policy, and future prospects. The volume ends with several creative and challenging views on alternative ways to view the biosphere and our place within it.

Too often we think of the loss of biodiversity only as a problem in tropical ecosystems. While these areas are clearly receiving the greatest insult, the problem is global. *Biodiversity* covers the topic comprehensively and, in my opinion, is a perfect primer for anyone wishing to become more knowledgeable about this topic. It is not just another doom and gloom treatise on how we humans have destroyed or are destroying our planet. It outlines the challenges as well as possible solutions through basic and applied research, and through economic, social, political, and philosophical reevaluation of our

impact upon our fellow species. Paul Ehrlich convinces the reader very early in the volume that the most serious problem confronting the preservation of biodiversity is habitat destruction. The cause of this problem is expressed quite succinctly in Terry Erwin's article: "Millions upon millions of nature's species being replaced by billions upon billions of hungry people." Existing solutions may not be sufficient to deal with these problems and the National Zoo's Michael Robinson says that "radical innovation" is required in developing alternatives to the destruction of biodiversity.

In his Epilogue to *Biodiversity*, the Smithsonian's David Challinor concludes on the hopeful note that it will be changes in the collective behaviors and perceptions of people toward their habitat that will start us toward a solution to the problem of maintaining global biodiversity. *Biodiversity* can help provide the awareness and understanding necessary to effect those changes.

*—S. Douglas Miller*
*National Wildlife Federation*

## FRONT PAGE FROGS

Last summer, July 30 to be exact, Ollie North and Ed Meese shared the front page of The Washington Post with a little-known amphibian—the African clawed frog. The news was from the National Institutes of Health, where a scientist studying the frogs had discovered an entirely new class of antibiotic that kills a variety of bacteria, fungus, and protozoa. Named magainins (a Hebrew word meaning shield), the microbe-killing chemicals were isolated from the skin of clawed frogs, common research animals known for their hardiness and resistance to infection. In fact, watching these frogs, after surgery, swim about in a muddy, germ-ridden tank without becoming infected inspired scientist Michael Zasloff, who was working on an entirely different problem, to search for magainins in the first place. The story is a text-book example of the role of serendipity—and academic freedom—in achieving stunning breakthroughs in science. It is also a text-book example of the value of preserving biological diversity, even in its most humble forms.

The African clawed frog (*Xenopus laevis*, meaning "smooth strange-foot") is a very primitive frog native to sub-Saharan Africa. It is Africa's most abundant and widespread species in the family Pipidae, a small relict group of frogs confined to Africa (11 species) and South America (five species). African clawed frogs and their pipid relatives are the only living frogs that lack tongues. Most frogs catch prey with a flick of a long, sticky tongue, but the African clawed frogs overcome their apparent disadvantage by being aquatic, catching moving prey in their mouth as they swim through the water and then shoving in larger items with their fork-like fingers. Claws, found on the tips of the inner three toes of their webbed feet, rake up mud and sand either to flush out hidden prey or to camouflage themselves from their own predators.

Although clawed frogs will eat almost anything that moves in the water (including their own tadpoles) they cannot eat a thing on land. Their terrestrial locomotion is also clumsy—they basically swim along the ground. So during the long African dry seasons, the frogs retire to the cool, damp subsoil where they estivate (the hot weather version of hibernation) until reappearing with the first rain to breed in every pond and puddle. Which brings us back to this frog's amazing antibiotic skin. Because frogs share small patches of stagnant water with a multitude of microorganisms, some defense was probably essential for the frogs' survival. Magainins seem to be that defense, enabling the frogs to live almost entirely in a murky aquatic environment.

Such a neat trick for the seemingly unremarkable creatures we might easily overlook in the NZP Reptile House. Neither spectacular nor bizarre, the African clawed frog is the kind of animal that evokes little concern when it is endangered, little regret when it is extinct. Indeed, it's a good thing that these frogs are abundant, because a campaign to "save the clawed frog" would likely have been met with derision. Who would have guessed that the slimy skin of this drab little frog may contain clues to curing cancer and cystic fibrosis?

*—Susan Lumpkin*

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